A DECISION ORIENTED MANAGEMENT INFORMATION SYSTEM IN A NAVAL SHIPYARD

Peter Bruce Bowman

A DECISION-ORIENTED

MANAGEMENT INFORMATION SYSTEM

IN A

NAVAL SHIPYARD

by

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Submitted to the Alfred P. Sloan School of Management on January 24, 1973 in partial fulfillment of the requirements for the degree of Master of Science in Management.

ABSTRACT

A management information system for use in the Production Department of a Naval Shipyard has been developed using the model-based decision-oriented systems design approach of Rockart, Gerrity and others. The Boston Naval Shipyard, Charlestown, Massachusetts, was used for the descriptive model. Where possible, the existing standard shipyard MIS was retained and included in the design.

The management information system design process has been broken down into three discrete segments:

a. Systems analysis--construction of normative and descriptive models.

b. Determination of system requirements--comparison of the normative and descriptive models to determine system requirements.

c. System development--development of a system to accomplish the requirements developed above.

After a brief shipyard orientation period, construction of the normative model was begun. For the descriptive model, three levels of management within the Production Department of the Boston Naval Shipyard were observed: foremen (first-line supervisors), the Repair Officer, and the Production Officer (department head). The observation period consisted of approximately one and a half months of close, daily contact with the managers involved. The decisions of these managers and information relating to them were recorded and later analyzed and categorized. After comparison of the normative and descriptive models to determine the information system requirements to support the decision categories for the managers, an MIS was designed to satisfy these requirements.

The authors have demonstrated the usefulness of the model-based, decision-oriented approach applied to the shipyard job shop environment, have proposed significant changes to the system currently in use in the naval shipyards, and recommend that potential application areas for the model-based, decision-oriented approach (i.e., other than job shop) be investigated.

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Title: Associate Professor of Management

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We are especially appreciative for the advice and direction provided by Professor Jack F. Rockart. We also are grateful to Professor Malcom M. Jones.

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INTRODUCTION

A. Statement of the Problem

The method utilized in the design of a management information system will certainly affect the delivered product and therefore the effectiveness of the operational system to aid and improve the management process. In practice, design methods in the past have ranged from the mere bottom-up conversion of existing manual data storage systems into computer data storage systems, to detailed, expensive and lengthy systems analysis design efforts. There is abundant literature which describes the methods utilized by past and current designers, and additionally provides historical examples and critiques of specific system designs.

It would be a harsh judgement to render that the current state-of-the-art in management information system design is inadequate and that management information systems are therefore ineffective. However, it is reasonable to state that management information systems have not proven to be as helpful to managers as systems designers in the past have heralded they would be. In the vivid description by Zani:[1]

> "Traditionally, management information systems have not really been designed at all. They have been spun off as by-products of the process of automating or improving existing systems within a company.
>
> When a company's information system comes into existence in this second-hand manner, it is largely fortuitous whether the information the system provides is exactly the sort of information the

managers in the company need to help them make their decisions. If it does turn out to be exactly what they need, then, well and good. If it does not--and this is much more likely to be the case--then clearly the so-called 'management information system' is merely a mechanism for cluttering managers' desks with costly, voluminous, and probably irrelevant printouts." (Underlining ours.)

Several authors have contributed ideas in an effort to develop a more rational and effective approach to management information systems (MIS). After summarizing conventional systems analysis approaches, Rockart states:[2]

"For nearly two decades, the above tools and techniques have been used to answer the question 'How does one go about the process of information systems analysis?' Their weakness, however, is that the significant questions in the systems study field are not begun with the interrogative 'how' but rather with 'what.' The truly serious questions for the systems analyst are 'What should I look at?' and 'What is the best approach to understanding this system?'"

The answer to the second of the latter two queries is proposed by Rockart to be a model-based systems analysis:

"The analyst who has a clear model of the area he is researching will do a faster and more effective job of systems analysis."[3]

It is herein hypothesized that the answer to the first query should be that the "what" to be looked at is the decision process of the organization and of each manager in the organization. The rationale for this stems from the view of Zani that:[4]

"Rather than mirroring existing procedures, ... an information system should be designed to focus on the critical tasks and decisions made within an organization and made to provide the kind of information that the manager needs to perform those tasks and make those decisions."

There are several potential advantages to this model-based, decision oriented approach to MIS design. It will assure that all important areas of the organization are examined and that deficiencies in the existing system are improved. If the design is done properly, it will also provide for future adjustments as the basic processes are improved. The resulting system will be one tailored to the organization and to the individuals in it, and will be capable of change as the key personnel change. It will reflect the goals and objectives of top management and will be purposefully constructed in a combination top-down and bottom-up manner vice the exclusive bottom-up manner typical in the past. It will influence decision making in the critical areas determined by top management and will thus "focus information technology and resources where they do the most good."[5]

B. Scope

The task of designing a model-based, decision-oriented information system for the total management of a naval shipyard is obviously one of very large proportions. There are ten operational naval shipyards in this Country employing approximately 50,000 people. Each shipyard has an annual business of almost 100 million dollars, and issues 400,000 design drawings and 700,000 individual job instructions yearly. In

addition, it maintains a material inventory of 121 million dollars with total annual value of transactions of almost 300 million dollars. This is comprised of 100,000 receipt transactions and 550,000 expenditure transactions. The nation's naval shipyards currently employ a standard MIS largely developed in the 1960's, and although currently in use, it is still an evolving management tool whose creation and implementation has already consumed tens of thousands of man days.

Thus, in our efforts to shed light on the systems design of a decision-oriented information system, we of necessity had to limit the scope of the problem to a manageable level; i.e., the project had to be of such magnitude that the supporting literature search, field observations, analysis, evaluation, system design and presentation could be adequately performed by two persons in a three- to four-month time frame.

With this in mind and taking into consideration the probable areas of endeavor in which we might find ourselves several years hence, our interest was focused on the "Production Department" of the Boston Naval Shipyard. (See Chapter III for a complete description of the mission, organizational structure, etc., of a naval shipyard.) Concisely stated, it is the task of the Production Department to execute in a timely fashion and within available funding, all approved ship and productive non-ship support work in connection with ship maintenance, overhaul and construction. There are approximately 3100 persons in the department to accomplish this task. Realizing also that thoroughness should take precedence over the alternative of a broad sample (at least for the purposes of this thesis), the study was confined to three levels of management within the Production Department: the Foreman, the Repair Officer, and the Production

Officer (the reader is again referred to Chapter III for more descriptive information). This selection had the added benefit of providing observations of management ranging from the first-line supervisor (Foreman) to the department head (Production Officer), as well as insight into interactions between low and high level management within the department.

C. Method

The most influential sources in the development of the method were the works of Rockart,[7] Gerrity,[8] Mintzberg,[9] and Zani.[10] The exact method employed is described in detail in Chapter II. Briefly, the model-based systems analysis of Rockart and Gerrity was first used to obtain a "normative" model of the level of management under consideration. Here the word normative is used to denote a model based on what the writers thought was the ideal prior to observation of the individual. This model concentrated on determining the decision areas in which production department managers should be involved. Each of four foremen was observed for a period of one week, as were both the Repair Officer and the Production Officer. Information from the observations was recorded on a form which, though not directly related to any used by Mintzberg, was influenced by his extensive coverage of the data gathering process.

This data was categorized using the approach suggested by Zani and Rockart, and a descriptive model was formulated. From the normative and descriptive models, a decision-oriented information system to support the three levels of management observed was constructed. The reader will note that we did not intend to formulate the entire information system, but rather attempted to make the existing system more meaningful and useful.

CHAPTER I.

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2. J.F. Rockart, "Model Based Systems Analysis: Methodology and Case Study," Industrial Management Review, II, 2, 4 (1970).
3. Ibid.
4. Zani, op. cit.
5. Ibid. 100

CHAPTER II.

METHOD OF DESIGN

A. General

The process of designing an information system can be viewed as consisting of three basic steps--system analysis, system development, and programming. It is necessary to state our definitions of the above terms because there does not appear to be a general agreement in the literature.

Design is the entire process utilized in converting from a manual system to an operating man-machine system. It encompasses all three of the basic steps. System analysis is the process of determining the requirements of the system being designed. System development is the process of determining and planning how the system will be implemented. It includes determining what the required inputs are to obtain the outputs desired, and determining the type and size of the hardware to be utilized. Programming is the implementation of the system.

The reader should take note that our use of the word design is different than that found in some of the literature. Frequently, the word design is used to describe both the overall process and the system development phase. Our definitions were arbitrarily selected, but are stated here in an effort to avoid confusion on the part of the reader.

It must be realized that there is definite overlap between the three basic steps, and that a more optimal system will result if the design path allows for iteration. These relations are illustrated in Figure II-1.

This paper is concerned only with the first two steps. It is centered on the process of developing the system requirements and the system

INFORMATION SYSTEM DESIGN PROCESS

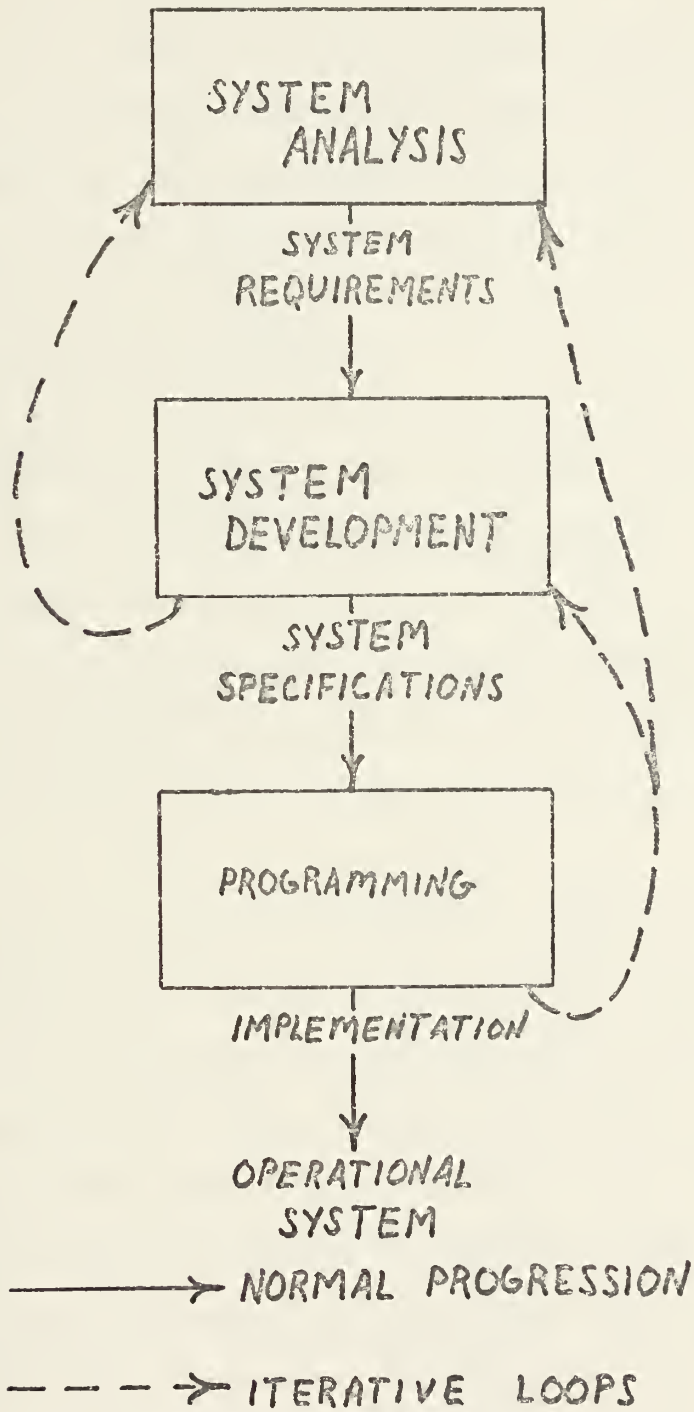

FIGURE II-1

specifications with regard to information. It does not consider the hardware implications, and the process of hardware selection. The authors do not intend for the reader to infer that hardware selection is not important. Rather, we feel that at the present time, the full utilization of existing hardware has not been realized, and the pursuit of finding ways to accomplish effective utilization is the more interesting problem.

B. Alternative Methods of Design

The need for development of a rational and effective approach to MIS design was described in Chapter I. The model-based, decision-oriented system design which is proposed as the method that will achieve the desired effectiveness is not the only approach available. In this section, a description and evaluation of the alternatives which are available is presented. The alternatives are a composite of the methods utilized in the past and of recent proposals by writers in the field of information technology.

Our approach is to take the statement by Rockart that, "The truly serious questions for the systems analyst are 'What should I look at?' and 'What is the best approach to understanding this system?'"[1] and attempt to answer the two queries. At the current time, the second seems to have only a limited range of possible answers--specifically, conventional systems analysis or model-based systems analysis. A search for the answer to the first question offers a wider range of possibilities. We have chosen to call the answers to "What should I look at?" the possible "orientations" of the design process. The spectrum includes decision, information flow, machine, process, data and functional orientations. This framework of alternatives is illustrated in Figure II-2, and is

DESIGN ALTERNATIVES ✓

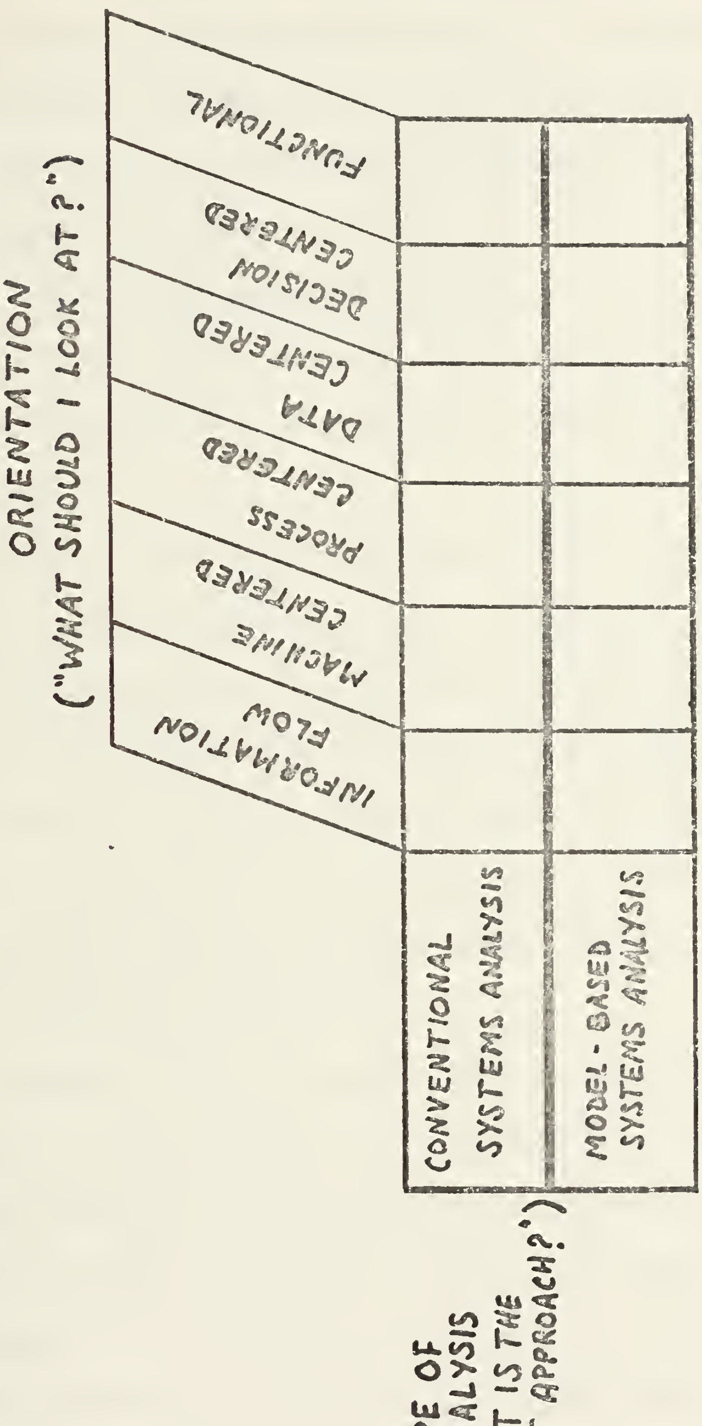

FIGURE II-2

discussed in detail below. We feel that all the reasonable alternatives available probably have not been considered, and hope that the imaginative reader will attempt to expand the matrix in both dimensions in an effort to further shed light on the design of management information systems.

1. Types of Approach

a. Conventional Systems Analysis

Conventional systems analysis as applied to information systems design is described by many authors, some of whose writings are discussed below.

Withington's first step in his very general "systems study" is oriented toward the determination of the "... functions and decisions required of management at the various levels in the organization." This is followed by a "pinpointing" of the information required to perform the work and make the decisions. The information is appropriately displayed by means of a flow or system chart, and after a clear understanding of the organization's information system needs, alternative mechanisms to supply these needs are devised.[2]

The procedure used by Gregory and Van Horne is more explicit:

"There are five steps the systems analyst must perform:

"First, obtain facts by interviewing and observing activities about the events--their type, volume and timing--that lead to the origination of documents, maintenance of files, issuance of reports, processing steps done at each work station, and flow of documents between stations.

"Second, collect sample copies of filled-in documents, file papers and reports...

"Third, study processing operations to learn the 'how' and 'why' of every document that each person receives or issues, what processing steps he performs, the nature of files he keeps or uses, and the contents of any reports he prepares.

"Fourth, organize the facts obtained into flow charts, flow lists or other suitable form to trace the path of data from origin through each stage of communication and processing into files, and out of files to reports.

"Fifth, interview each user of documents and reports to learn what information he uses in his work and what he thinks he needs."[3]

Glans, et al, divide the analysis into two steps:

"Understanding the Present System

In order to understand the present system, analysts try to determine what is done in the organization, using what inputs, with what resources, to achieve what results.

"Determining System Requirements

In determining the requirements of a system, two main questions arise: (1) What is the system required to do, now and in the future? (2) How well must it perform to fulfill these requirements? ... Collection and review of information constitute the first steps in determining the requirements of the system."[4]

Thus it is seen that conventional systems analysis provides the designer with a descriptive model of the current system and a determination of system requirements.

b. Model-based Systems Analysis

The concept of model-based systems analysis was first explicitly stated by Rockart[5] in 1970 and elaborated upon that same year by Gerrity.[6] The foundation of their thesis can be located in the works of Nadler,[7] Carroll,[8] and Pounds.[9]

The significant contribution of the model-based approach is the requirement that the analyst formulate a normative model of the system to be studied prior to development of the detailed descriptive model of the system. The purpose of having a normative model is to guide the analyst to the important areas and to give him a benchmark for comparison with the descriptive model. This comparison is used to generate alternatives and then system requirements, as well as pinpoint the current system flaws.

Gerrity describes the major function of the normative model in the following manner:

> "Construction of or search for normative models is aimed at uncovering desirable standards for comparison with the current system. It involves the specification of characteristics and behaviour of an ideal system. These characteristics may be derived from a number of sources: direct elaboration of system goals, search of the literature, similar systems elsewhere, abstract optimizing models, people in the system, etc."[10]

In order to obtain a realistic normative model that will be applicable, a certain amount of descriptive modeling must be accomplished along with the development of the normative model. The implication of this is that the process is an iterative one. This iterative nature cannot be over

emphasized, especially where the analyst is involved in newer application areas. The intended framework is displayed in Figure II-3.

c. Evaluation of Approaches

The conventional analysis approach to problems possesses several advances over previously used methods. The basic technique is relatively formal, applicable to a wide variety of situations and capable of being learned without excessive effort. Although there is no standard guidance on how to generate alternatives, emphasis is placed on their generation, display, evaluation and relative ranking. Perhaps the greatest advantage of systems analysis over earlier methods is the communications improvement which it provides. Systems analysts "talk the same language;" different groups working on related problems can relatively easily comprehend the status of work in progress, compare alternatives, and the like.

Model-based systems analysis possesses not only the advantages of the conventional approach, but goes beyond. By comparing the descriptive and normative models, the analyst should be more rapid, effective, and efficient in defining problem areas. As Rockart states:

> "Where the study is merely seen as 'finding out how the current system can best be computerized' (i.e. conventional systems analysis) important dimensions of the process can be overlooked. Model-based, problem finding, systems analysis assists in ensuring (1) that no important areas of the system are overlooked, (2) that deficiencies in the current process are identified and improved, and (3) that the information system is designed to be able to adjust to and take advantage of improvements in the basic process as they are carried out."[11]

MODEL BASED
SYSTEMS ANALYSIS

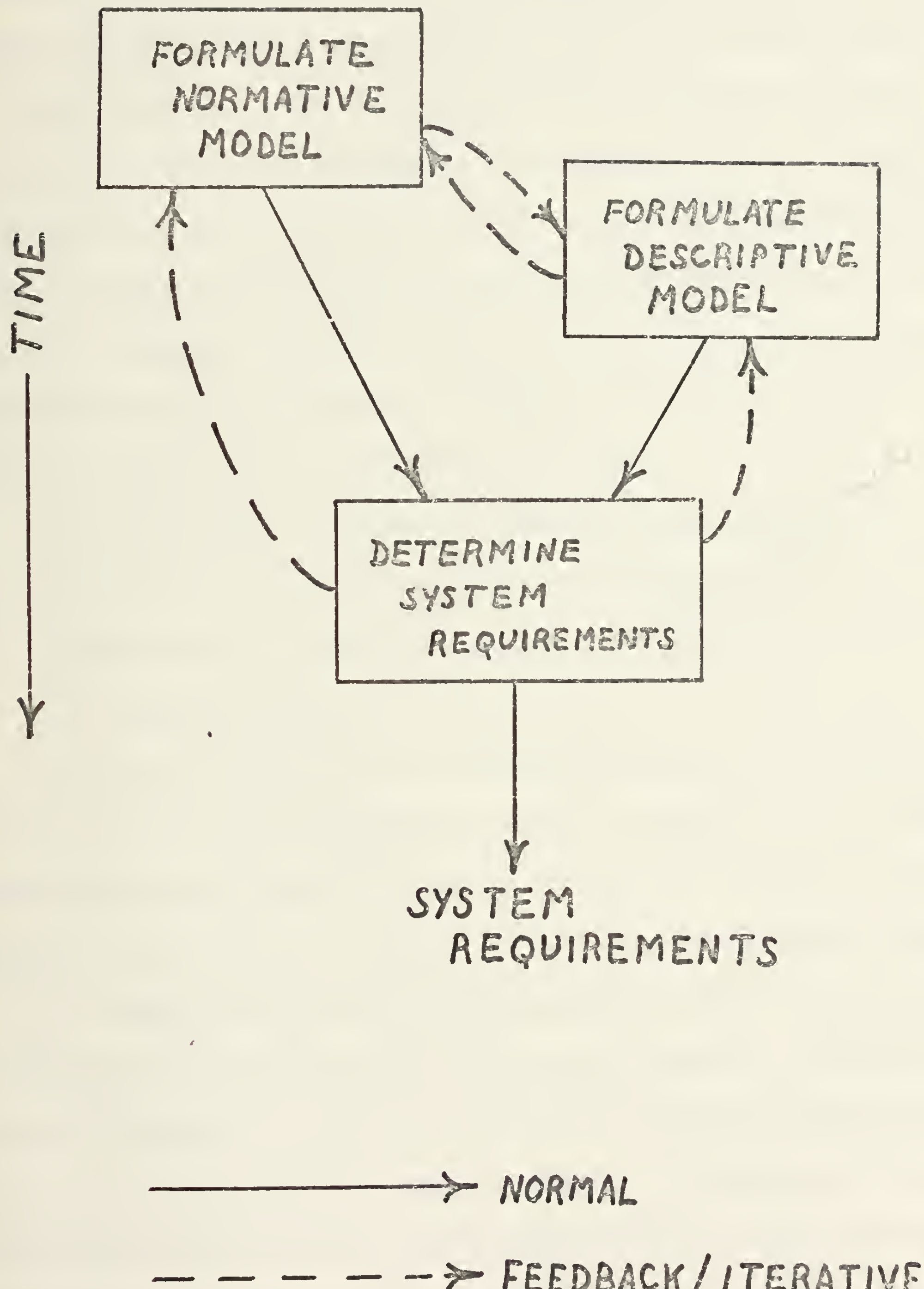

FIGURE II-3

From this Poundsian problem-finding approach, initial specifications are developed in response to "gaps" identified in the comparison of the normative and descriptive models. If the normative model is constructed before the bulk of the descriptive model, it is also quite possible that the final design may tend to be more creative and less susceptible to sub-optimal, incremental improvements of the current system. The modeler may thus focus on "what should be" rather than "what is" and the normative model may extend the designers' planning horizon by becoming a long run standard. However, the danger exists that the normative model may be developed with too much insulation from the real situation and prove to be naive or infeasible. Gerrity points out that:

> "In the extreme ... normative modeling cannot begin without some minimal notion of the descriptive structure and goals of the real process. Hence descriptive and normative modeling must be parallel activities to some extent."[12]

There can be a non-simple relationship between the normative and descriptive models. The descriptive model may suggest human, economic or technological constraints on the feasibility of the normative model. In severe cases, it may even suggest omissions to the normative model.

It appears that the model-based approach is more readily adaptable to Anthony's "strategic planning, management control, and operational control"[13] framework, whereas conventional systems analysis seems well suited only to operational control problems. Its tendency to focus on structured day-to-day activities and relationships in the formulation of the descriptive model, and its frequent only step improvement over the current system renders conventional systems analysis less appropriate for

management control and strategic planning problems. The model-based approach tends to give the analyst a more global view, and its emphasis on goals/objectives, primary functions, and ideal relationships appears to be more appropriate for the whole spectrum of Anthony's framework.

These same qualities of the model-based approach also make it more appropriate for application to the Gorry-Scott Morton framework[14] for management information systems, specifically in the areas of semi-structured and unstructured problems. As these two authors point out, most efforts in the past have focused on the upper left-hand corner of their nine-celled matrix (see Figure II-4). To relieve this imbalance, future applications will be not only in the areas of management control and strategic planning, but also toward the solution of unstructured problems. It is our belief that the model-based systems analysis approach is a viable method by which progress in these areas will be obtained.

2. Orientations--"What to look at"

A review of previously-utilized orientations includes:

a. Information Flow

The primary objective of a system which concentrates on analyzing information flows will be to improve the efficiency of the current system. This approach may be applicable where there already exists a machine-based system which is in need of improvement, but which already has the basic elements contained in the appropriate normative model and performs the functions desired by management, but not as well as desired. It can be expected to provide only incremental improvements. Selection of this method must be preceeded by the determination that efficiency is what is needed. Concentrating on information flows will not lead the analyst

INFORMATION SYSTEMS FRAMEWORK ✓

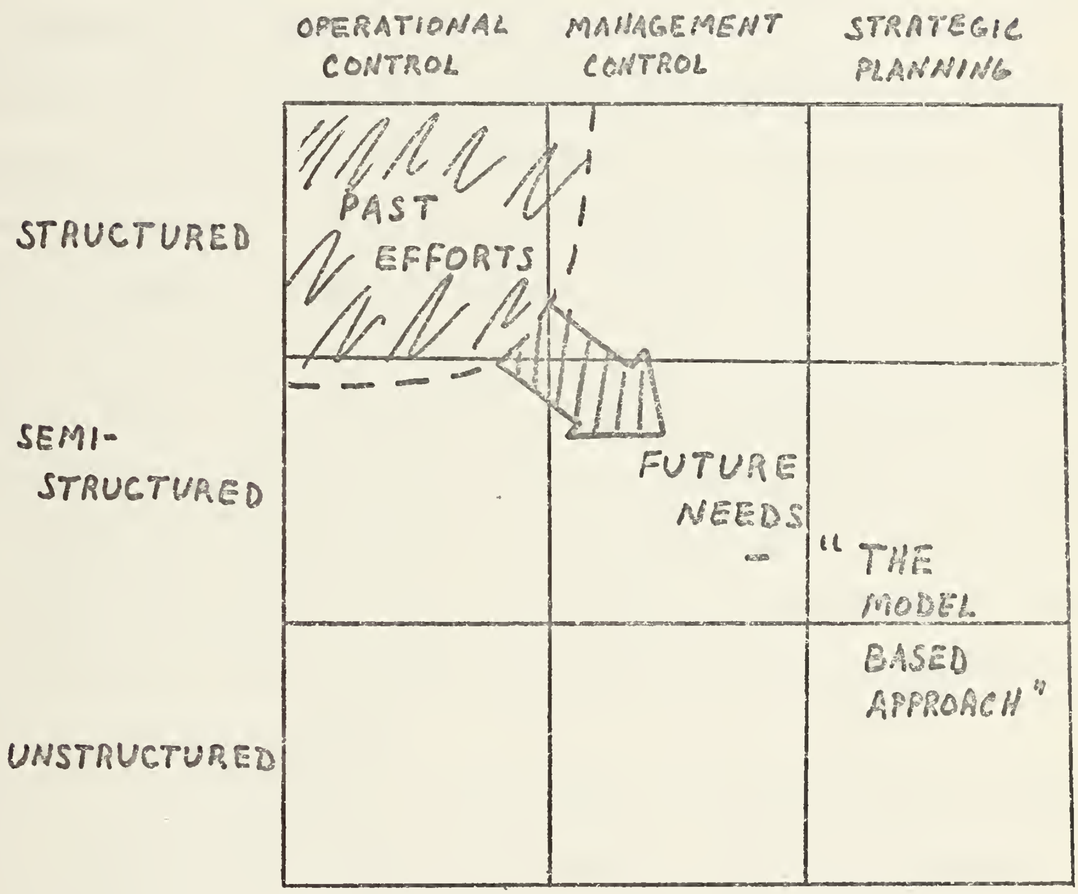

FIGURE II-4

to ask, "What is this information for?" and "Is it really needed?" The danger is that you will produce an efficient but ineffective system.

b. Machine Centered

The machine-centered design concept is similar to the information flow method in that both are concerned with efficiency. In this case, it is "hardware system efficiency, thruput, and capacity utilization."[15] This approach has its advantages in large data storage-retrieval systems where there is little or no "data processing." It is not appropriate for the type of information system which is intended to aid the manager to improve the management processes. Hardware costs are decreasing relative to the human costs in systems development and operation, and this trend is expected to continue. The price paid for a machine-centered design is a system relatively insensitive to user needs and problems. From the few experiences we have had, and from cases we have studied, the most certain way to make a MIS ineffective and unused is to insulate it from the user in that manner. The result is an undesirable escalation in the cost benefit ratio.

c. Process Centered

A process-centered orientation is "characterized by a factoring of an existing process into small modules...(and) no real thought is given to overall redesign."[16] This may result in incremental improvements in efficiency, but is seen to be little more than a conversion of a manual process into a machine process. It has already been noted in Chapter I that this has resulted in sub-optimal systems.

d. Data Centered

The data-centered orientation is well described by Gerrity: "The philosophy of this approach is often called 'total systems.'

It manifests itself in the design of systems from the bottom up, starting with the data base. The notion seems to be that if one starts with all of the operational control data in an organization and builds up from there, then one will eventually arrive at the integrated system which will serve the decision needs of all, including top managers.... The design is driven by the availability of a large machine-readable data base, rather than by carefully defined problem-oriented requirements."[17]

This orientation has some advantages. The large data base can allow for flexible and easily changeable outputs as needs, situations, and personnel change. There is the base data which can be aggregated properly for use at higher levels of management. There are also problems with this orientation. Too much emphasis is placed on data and not enough on output and the system. Managers at all levels are left to determine their own needs without any overall coordination. The large data base may require undue investment in hardware as well as unnecessarily high operating costs for collecting and maintaining the data. It also holds the illusion for top management that the large operational data base may be capable of providing all the data which could be of use in their decisions, and which can be automated. It is clear to us that such is not the case.

e. Decision Centered

The basic purpose of the manager in an organization is to make decisions. Decision making depends on many factors, but prime among these is the information available. It is logical to therefore consider a decision-oriented MIS. Additionally, in the framework of Gorry and Scott

Morton in Figure II-4, a decision-oriented system would appear to be a method for expanding the applicability of MIS toward the less structured management control and strategic planning areas. Simply stated, that is the case for such an approach. Whether this is reasonable remains to be seen and is the topic of this paper.

The danger of this approach lies in becoming focused on what decisions are made versus what decisions should be made. Hopefully at this point the reader will see the proposed logic for a model-based, decision-oriented approach.

f. Functional

Among several authors who mention a "functional" orientation, Dearden[18, 19] seems to come closest to what we intend. The idea would be to analyze the system by looking at each of the major functions performed in the organization. Dearden's views that there should be separate financial, inventory control, personnel, etc. subsystems seem to illustrate the major difficulty. Specifically, it tends to isolate each block and concentrate on what is within, with little attention to the interfaces between blocks. As with the decision-oriented system, the coupling of the functional orientation and the model-based approach provides another new alternative to the system designer.

3. Other Considerations

While not dealt with explicitly in the previous discussions on the basic types of analysis and orientation, there are a number of other points that must be considered in the design of an information system. The most important of these are user involvement and the cost benefit tradeoff involved in the design process. There are many others, but it is not the

intent of this paper to discuss in detail the procedure of building good models, or to discuss the very real problems of programming, machine compatibility, or system implementation and the like.

User involvement is not a new concept, but all too often it has been neglected in the past. In some cases it appears that the user was neglected entirely; in others, the designer thought he was obtaining user involvement, when in fact the end product and its disuse by management demonstrated the fallacy (the Gershefsky Sun Oil Company case is a glowing example). Another example of the misuse of this principle is seen in the naval shipyard MIS discussed here where some low-level management was apparently involved in the design process, but the bulk of middle-level and higher management apparently was not. Zani suggests an information system "...smartly tailored to the company from the top down, and not merely patched together from the bottom up in a crazy quilt of residues from automated clerical procedures." He further states:

> "To ensure that the framework will actually be used, however, top management must take a more prominent role in the design process than it has hitherto. Most experts agree that top-management support and participation are necessary for effective design, but they generally state that this support is necessary only for budget control of the data-processing group...Top management must start the design process--i.e. must first delineate the organizations strategy, structure, and decision-making process for the specialists in the design group, and then make sure that the specialist designers integrate these elements fully into the basic system design."[20]

Zani is overly enthusiastic about the role of top management; in fact, one must design using a combination of top-down and bottom-up approaches. But, his point about top management involvement and the success of an MIS is clear. Blumenthal states that "...the user organization is responsible for carrying out investigatory activities leading to a determination of needs...."[21] Whether or not one agrees with Zani or Blumenthal, it is clear that without active user participation in its design, an information system is doomed to fail because it will almost certainly be rejected by its intended users.

The cost/benefit tradeoff involved in the design process comes to light in the determination of how detailed the analysis and eventual design will be. It is obvious that given sufficient time and funds, every decision (in a decision-oriented approach for example) a manager makes could be analyzed, and eventually be supported by a very complex MIS. However, although the benefits of such a system would be unquestionable, the cost for any firm would be astronomical! Nor could the system be completed in any finite period of time. It is clear that the design process should focus on the critical relationships within an organization and seek to provide information that the manager needs to perform the key tasks.

4. Selection

The alternative approaches and orientations discussed suggest that a model-based, decision-oriented design is an appropriate method for the design of an MIS. The combination can potentially be very responsive to providing a useful and effective system which will aid the manager in improving the management process. The advantages have already been discussed above and in Chapter I. The chapters that follow discuss our efforts to use this

method and the results obtained. The next section of this chapter describes the procedures we utilized.

C. Procedure

1. General

In order to apply the model-based, decision-oriented method developed above to the design of an information system for management of a naval shipyard, it was necessary to have a general procedure. As discussed in Chapter I, due to practical considerations, our interest was focused on the Production Department of the Boston Naval Shipyard at three different levels of management. It was also our intent to pursue only the analysis and development steps of the design process. The diagram in Figure II-5 is the basic procedure we established. Not shown on the diagram is the time we utilized researching systems analysis and data gathering techniques. The means of accomplishing the procedure are described in the remainder of this section.

2. Systems Analysis

a. Formulate the Normative Model

Both of the authors had prior experience with naval shipyards, but in the role of "customer," and even this was several years prior to this project. To formulate the normative model, it was therefore necessary to familiarize ourselves with the basic shipyard system and organization. This was accomplished in several ways. We first attended a five-day course on the shipyard MIS conducted by Harbridge House, Inc. The majority of the other participants were shipyard foremen. Ideally, this would have been more valuable had we attended the course when we were constructing

MODEL BASED SYSTEMS ANALYSIS IN THE SHIPYARD

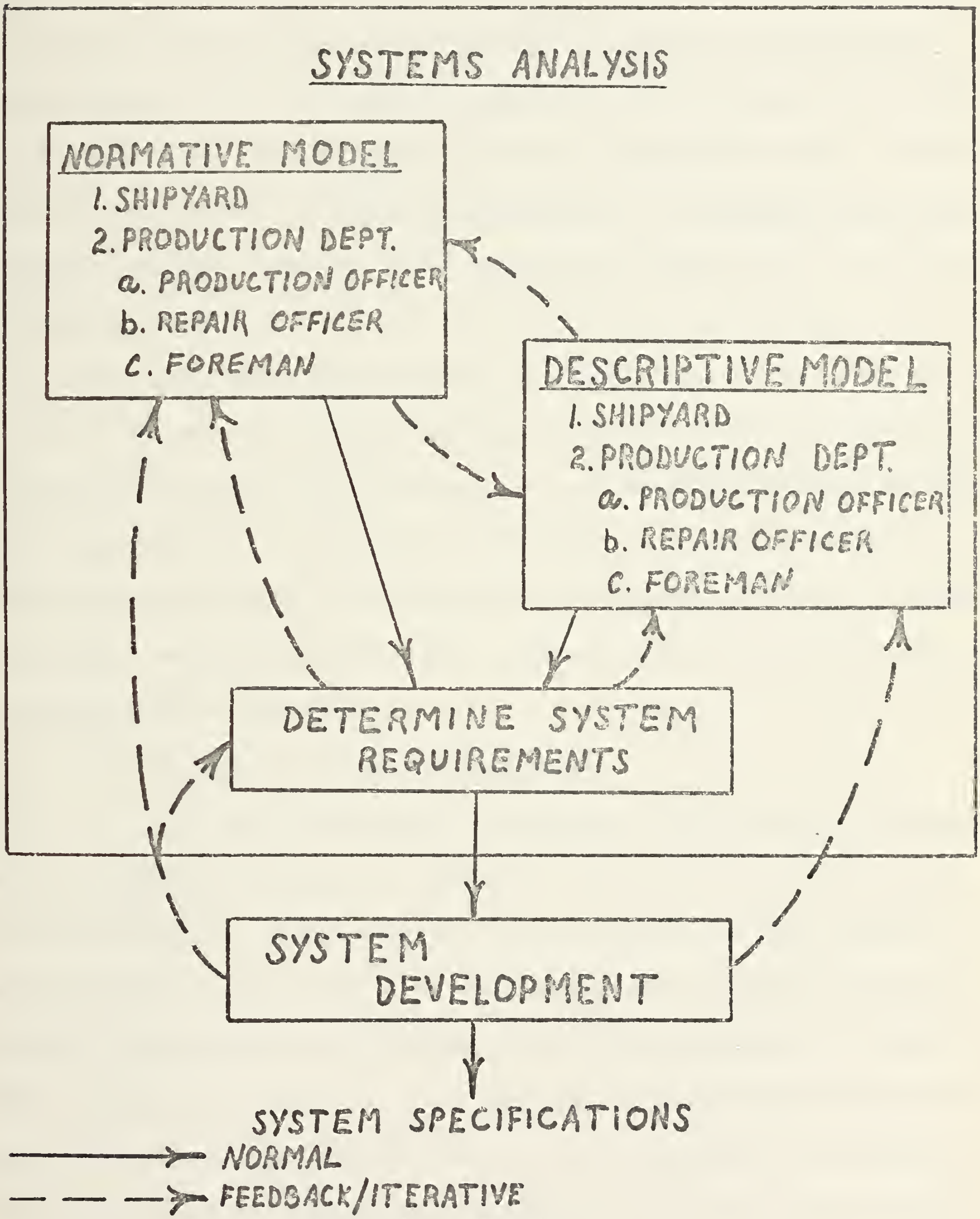

FIGURE II-5

the detailed descriptive model, but time constraints did not permit it. The next step was to tour the shipyard physical plant with the able and knowledgeable Mr. McKenzie, a long time employee of the yard. Coincident with the tour were several interviews with middle- and upper-level managers, each generally of an hour duration. This took about one-and-a-half weeks, during which there were unavoidable periods of delay and waiting. We also read publications such as Shipyard Regulations, the Planning, Production and Control Manual, portions of the Shipyard MIS manuals, etc. Of prime importance during this period were discussions between the authors at the end of each day which attempted to relate our observations to our prior knowledge of "ideal" systems--our initial "normative" model. Prior to commencing our detailed descriptive study, therefore, we had formulated a normative model that was applicable to the shipyard environment. Our major attention throughout was on major decision areas, what managers should be involved in those areas, and what information was required. Where possible we attempted to address specific decisions.

b. Formulate the Descriptive Model

The major activity in constructing the detailed descriptive model was actually observing the managers and recording their decisions. The method utilized is discussed in the next section of this chapter. It was arbitrarily decided that a one-week period would be spent with each manager. We each observed two foremen and jointly observed the Repair Officer and Production Officer. This added to the descriptive modeling that necessarily occurred in the previous step. Additionally, we interviewed several other people, and expanded interviews with some of the people we had talked to earlier. We examined messages, mail, MIS outputs and other

documents. It must be noted that this was done on a random basis, but only due to the time and manpower constraints. More formal techniques might be appropriate in a full scale design effort. The completion of the observation periods marked the end of our planned descriptive data gathering. As anticipated, however, we occasionally had to reopen the manuals or seek more information from various managers to amplify and clarify our knowledge. From this compiled information, we constructed the descriptive model of what decisions were made, who made them, and what information and information sources they used.

c. System Requirements

The specification of the system requirements was accomplished by utilizing summarized statements of the normative and descriptive models using an outline of the normative model as a guide. This served to focus our attention on all relevant areas, and provided a logical base for development of the requirements. It clearly exposed both the strong and weak areas of the system, and from that framework were developed the specific system requirements. They were a coordinated series of statements that provided the input to procede with the next phase, the System Development.

3. System Development

System development involved us in trying to design the specifics of the data collection and the information outputs which would implement the system requirements. In most cases, the current MIS system already had the needed data. Where this was not true, we attempted to make the data input function simple and compatible with the current MIS. As throughout the entire design process, the system development phase was decision oriented.

4. Iteration

For us to portray that our efforts were divided so neatly into the above steps would hopefully cause the reader to question the veracity of our description. In actuality, we were continually cycling through the steps as we actively participated in the data gathering. The discipline of organizing and writing this paper then forced us into a more systematic progression through the loop. Even then, however, we were jumping ahead and/or going back to other phases. The point is that the process, in fact, was iterative. Conceivably, one could say that iteration is an excuse for whatever shortcomings the basic process has. We prefer to look upon it more kindly and recognize that it does occur and probably should occur. Throughout the process, we followed the basic paths we had previously developed, but we anticipated the iterative nature, and therefore were able to use it to advantage.

D. Data Gathering Methods

1. General

Having developed a procedure, the designer must next address the task of selection of appropriate methods of data acquisition and analysis. It is clear that the problem definition and approach will have a significant effect on the methods eventually selected. A brief review of possible methods, and the rationale used by the authors in selection is presented. Finally, the process used in data reduction and analysis is described.

2. Methods Considered

The three methods considered--interviews/questionnaires, diaries, observation--are amply discussed in the literature. An excellent summary of this coverage is contained in the work of Mintzberg.[22]

a. Interviews/Questionnaires

This method of data collection is espoused by many authors on the subject of information system design. However, one must understand the implications if this method is selected. The manager may tend to become the researcher and express himself in normative rather than descriptive terms. As McGregor states:

> "The manager's verbal statements about his style are after-the-fact generalizations that involve considerable rationalization. Often what he says about his style appears to others to be inconsistent with his day-to-day behaviour."[23]

Interviews do allow the researcher to delve into areas which he thinks are important, but this will prove rewarding only if he is right. Mailed or otherwise distributed questionnaires have the advantage of allowing a small number of researchers to contact a large number of managers.

b. Diaries

The diary is "an activity-by-activity tabulation of a number of parameters recorded by a manager."[24] It is a fairly popular method among researchers and often utilizes precoded words to simplify the diary keeper's task. It has the advantage of making it possible to study many managers for extended time periods, but possesses the same lack of objectivity as the interview/questionnaire. There also may exist some inconsistency in recording due to the differing degree of attention given by the diary keepers in maintaining the records. Mintzberg cites two related criticisms: "(1) ...the neat categories required for diary recording are not characteristic of managerial work, and (2) the manager is far too busy to record properly."[25]

c. Observation

In this method, the researcher relies heavily on his ability to interpret and record the manager's activities, information sources, and decisions. It is essential that the observer know what to look for, and how to describe or classify the events that he is witness to. As Carlson states, "Without such a conceptual framework, there would be no way of selecting among the infinite number of factual observations which can be made about any concrete phenomena...."[26] In this process, the observer acts as a kind of "black box," taking as inputs his observations, and producing his interpretation and categorization of them as output. As in the other methods described, there will be a bias introduced, but at least this bias is consistent across all observations because it belongs to the observer. Two relevant criticisms of this method are put forth by Rosemary Stewart in her comparative study of data collection methods:

(1) "It is hard for an observer to follow all that is being done, without interrupting the manager, even if he is familiar with the job he is observing. The difficulty becomes much greater when observing an unfamiliar...job."

(2) "...an observer may be excluded from confidential discussions."[27]

3. Selection

Although each of the possible alternatives has limitations, it became evident that the method which was most compatible with the model-based, decision-oriented approach was the observation technique. This method appeared to be optimal from the standpoints of objectivity and adaptability to

decision analysis, as well as requiring the least effort on the part of the manager under observation. The manager bias generated by both diaries and interviews was deemed unacceptable, and the central deficiency of observation, that of developing a conceptual framework as proposed by Carlson, was overcome as a by-product of the normative model development. It was clear to both of us that we should attempt to minimize interruption of the manager under observation, although some intrusion could not be avoided. As visitors to the shipyard, both we and the people we observed were aware that some items which might come up during the observation period could be deemed confidential, and thus not disclosable to us. However, this situation was practically non-existent, and the frankness of our subjects was both evident and appreciated.

To aid the observation process, a data collection sheet based on individual decisions was devised prior to the initial observation. Attempts were made to ensure that it was both simple and flexible yet complete. Based on the first week's observation experience, the data sheet was revised, the final form being shown in Figure II-6.

E. Data Reduction and Analysis:

During the four-week observation period, the authors met almost daily to discuss the implications of the data obtained. Additionally, upon completion of observation of a particular manager, summaries were drawn up outlining:

a.) the major decision areas and their content;

b.) the informational source the manager interacted with in the decision (who or what document);

c.) the type of information utilized by the manager in making

DATA SHEET ✓

WHAT KEYED THE DECISION	INFORMATION SOURCE AND CONTENT	DECISION/ CONTENT	WHO INTER-ACTED WITH	IMPLICATIONS OF THE DECISION	REMARKS

FIGURE II-6

the decision;

d.) the relative importance of each decision area;

e.) the approximate percentage of the manager's time spent in each area (foreman only);

f.) the adequacy of support given by the information system in each decision area.

From this analysis, diagrams were constructed to illuminate informational flow and decision area interrelationships.

Two significant decision related areas were also felt to merit consideration in more detail: the present shipyard control system and the current usage of the standard shipyard MIS within the Production Department.

CHAPTER II

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CHAPTER III.

THE BOSTON NAVAL SHIPYARD--BACKGROUND AND PERSPECTIVE

A. General

As discussed in the last chapter, both of the authors had prior experience with naval shipyards, but only in the role of "customer." Our very incomplete knowledge dictated that a sizable effort be expended toward achievement of a working knowledge of a naval shipyard. The ten naval shipyards are each organized and operated in a standard manner. Although management style and emphasis vary among the yards, Boston Naval Shipyard can be considered as representative. The purpose of this chapter is to describe the naval shipyard setting to provide the reader with the necessary background and perspective with which to evaluate our efforts, especially in the areas of modeling and design.

B. Mission and Capability

The official mission assigned to the Boston Naval Shipyard is:

> "To provide logistic support for assigned ships and service craft; to perform authorized work in connection with construction, conversion, overhaul, repair, alteration, drydocking, and outfitting of ships and craft, as assigned; to perform manufacturing, research, development, and test work, as assigned; and to provide services and material to other activities and units, as directed by competent authority."[1]

The principle role of the shipyard is the overhaul, repair and conversion of naval ships, which for Boston are primarily destroyers. It should be noted that while these tasks are also traditionally carried out by

civilian shipyards, naval shipyards in addition must:

- provide logistic support for ships and dependent shore facilities;
- perform research, development and test work for the Department of the Navy; and
- outfit ships built at civilian shipyards.

Naval shipyards owe their continued existence primarily to the necessary industrial capacity base capable of rapid expansion in time of national emergency which they provide. Although Boston Naval Shipyard now employs approximately 5500 people, during World War II this figure was roughly 50,000. Also of importance are the workforce stability provided by law which prevents government shipyard employees from striking, and the competition or standard by which to judge civilian shipyard performance.

By any standard, Boston Naval Shipyard is a large industrial complex. Its approximate annual statistics include:[2]

Business volume	$100 million
Parts Inventory	$121 million
	45,000 line items
Material transactions	$300 million
	100,000 individual receipts
	500,000 individual expenditures
Design drawings issued	400 thousand
Job orders issued	50 thousand
Job instructions	700 thousand

Although capabilities vary between shipyards, largely because of the principal ship type that each supports, the naval shipyard complex can handle

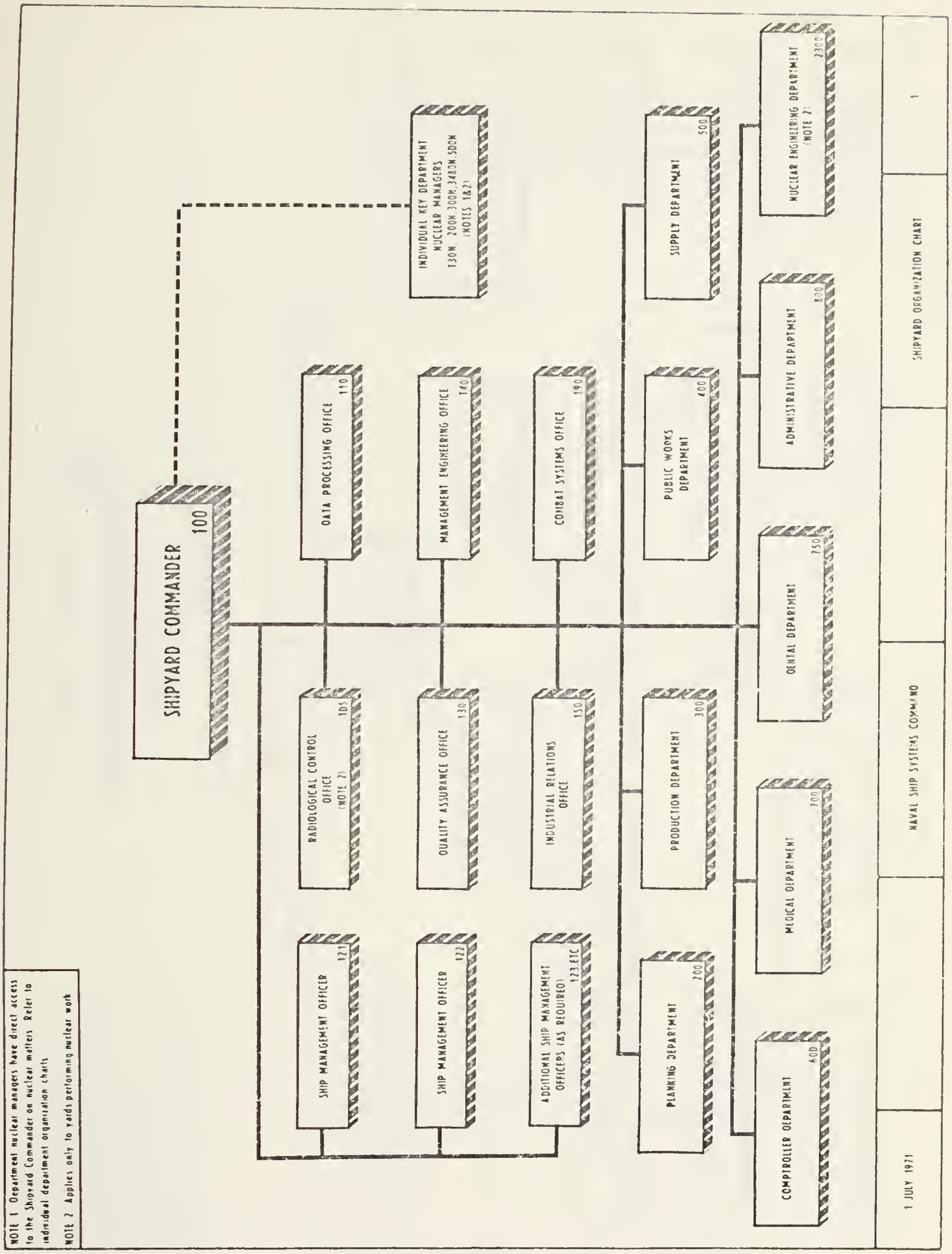
the full spectrum of technical support for the modern Navy, including sophisticated guided missile installation and repair, nuclear power plant installation and refuelling, and drydocking of the largest vessels in the Navy's inventory. A significant portion of the nation's shipbuilding capability is vested in its naval shipyards.

C. Organizational Structure

The organization of a naval shipyard conforms to the standard prescribed by Commander, Naval Ship Systems Command (NAVSHIPS), except where deviations are specifically approved by NAVSHIPS. The Boston Naval Shipyard has adopted this organization with only minor changes. There is no capability at Boston to perform nuclear repair work, and the Computer Applications Support and Development Office (CASDO) and the Planning and Estimating for Repair and Alterations (ASW) Office (PERA(ASW)) report to the Shipyard Commander only for administrative purposes. The line departments are functionally separated and report directly to the Shipyard Commander. There are several supporting staff departments which also report to the Commander. The activities and planning of the departments are coordinated by several working groups and committees which report to the Commander. The standard organization is presented in Figure III-1.

The Production Department is organized as shown in Figure III-2 with the exception that Boston has no nuclear capability. The Production Officer is a military officer and is primarily responsible for the accomplishment of work assigned in a timely and minimum-cost fashion. There are two main lines in the organization that support him.

The four group superintendents and their individual organizations are considered the "line" organization. Each group superintendent has several



SHIPYARD COMMANDER 100
INDIVIDUAL KEY DEPARTMENT NUCLEAR MANAGERS 130N, 200N, 300N, 3480N, 5D0N (NOTES 1&2)
DATA PROCESSING OFFICE 110
MANAGEMENT ENGINEERING OFFICE 140
COMBAT SYSTEMS OFFICE 190
RADIOLOGICAL CONTROL OFFICE (NOTE 2) 105
QUALITY ASSURANCE OFFICE 130
INDUSTRIAL RELATIONS OFFICE 150
SHIP MANAGEMENT OFFICER 121
SHIP MANAGEMENT OFFICER 122
ADDITIONAL SHIP MANAGEMENT OFFICERS (AS REQUIRED) 123,ETC
SUPPLY DEPARTMENT 500
PUBLIC WORKS DEPARTMENT 400
PRODUCTION DEPARTMENT 300
PLANNING DEPARTMENT 200
NUCLEAR ENGINEERING DEPARTMENT (NOTE 2) 2300
ADMINISTRATIVE DEPARTMENT 800
DENTAL DEPARTMENT 750
MEDICAL DEPARTMENT 700
COMPTROLLER DEPARTMENT 600
NOTE 1 Department nuclear managers have direct access to the Shipyard Commander on nuclear matters. Refer to individual department organization charts
NOTE 2 Applies only to yards performing nuclear work
1 JULY 1971
NAVAL SHIP SYSTEMS COMMAND
SHIPYARD ORGANIZATION CHART
1

FIGURE III-1

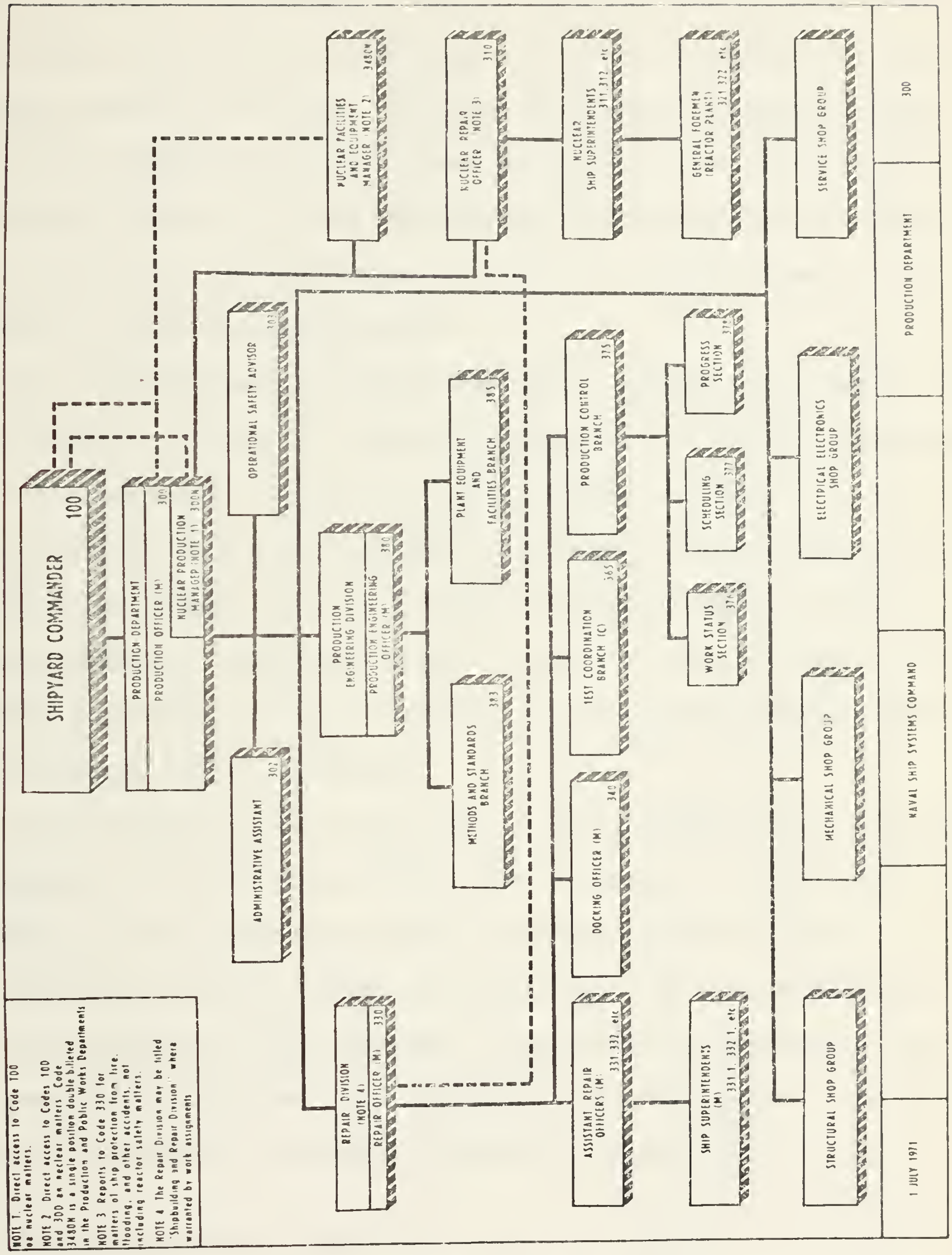

NOTE 1. Direct access to Code 100 on nuclear matters.
NOTE 2. Direct access to Codes 100 and 300 on nuclear matters. Code 3480N is a single position double billeted in the Production and Public Works Departments.
NOTE 3. Reports to Code 330 for matters of ship protection from fire, flooding, and other accidents, not including reactor safety matters.
NOTE 4. The Repair Division may be titled "Shipbuilding and Repair Division" where warranted by work assignments.
SHIPYARD COMMANDER 100
PRODUCTION DEPARTMENT
PRODUCTION OFFICER (M) 300
NUCLEAR PRODUCTION MANAGER (NOTE 1) 300N
OPERATIONAL SAFETY ADVISOR 303
ADMINISTRATIVE ASSISTANT 302
NUCLEAR FACILITIES AND EQUIPMENT MANAGER (NOTE 2) 3480N
NUCLEAR REPAIR OFFICER (NOTE 3) 310
NUCLEAR SHIP SUPERINTENDENTS 311, 312 etc
GENERAL FOREMEN (REACTOR PLANT) 321, 322 etc
SERVICE SHOP GROUP
PRODUCTION ENGINEERING DIVISION
PRODUCTION ENGINEERING OFFICER (M) 380
PLANT EQUIPMENT AND FACILITIES BRANCH 385
METHODS AND STANDARDS BRANCH 383
PRODUCTION CONTROL BRANCH 375
PROGRESS SECTION 378
SCHEDULING SECTION 377
WORK STATUS SECTION 376
TEST COORDINATION BRANCH (C) 365
DOCKING OFFICER (M) 340
ELECTRICAL ELECTRONICS SHOP GROUP
MECHANICAL SHOP GROUP
STRUCTURAL SHOP GROUP
REPAIR DIVISION (NOTE 4)
REPAIR OFFICER (M) 330
ASSISTANT REPAIR OFFICERS (M) 331, 332, etc
SHIP SUPERINTENDENTS (M) 331.1, 332.1, etc
300
PRODUCTION DEPARTMENT
NAVAL SHIP SYSTEMS COMMAND
1 JULY 1971

FIGURE III-2

shops for which he is responsible and each shop has a shop superintendent that reports to his group superintendent. There is an administrative and planning staff for each group. The shops have general foremen who report to the shop superintendent, and foremen who report to the general foremen. Generally, a foreman will have approximately 15-20 mechanics and laborers in his team, and a general foreman will have four or five foremen. All personnel in this line are civilians.

The "staff" organization of the Production Department is headed by the Repair Officer. Through his Assistant Repair Officers and Ship Superintendents, he directs and monitors the progress of ship and shop work. All of these personnel are military officers. This part of the department can be considered as project oriented, and the ship superintendents act much as project managers. The Production Control Branch through the Repair Officer provides scheduling, work load forecasing and work progressing functions. These personnel are all civilians.

The overlay of the two basic lines is shown in Figure III-3. The project orientation of the Repair Officer line is apparent, and the work load of specific job orientation of the Group Superintendent line is also.

Though not studied in detail in this project, the functioning of the Planning Department is very important to the Production Department. There are many interfaces between them which will be discussed later. The organization of the Planning Department is shown in Figure III-4.

D. Shipyard Industrial Operations

As stated earlier, the primary mission of the Boston Naval Shipyard is the overhaul, repair and conversion of naval ships. The overhaul is the

THE PRODUCTION DEPARTMENT

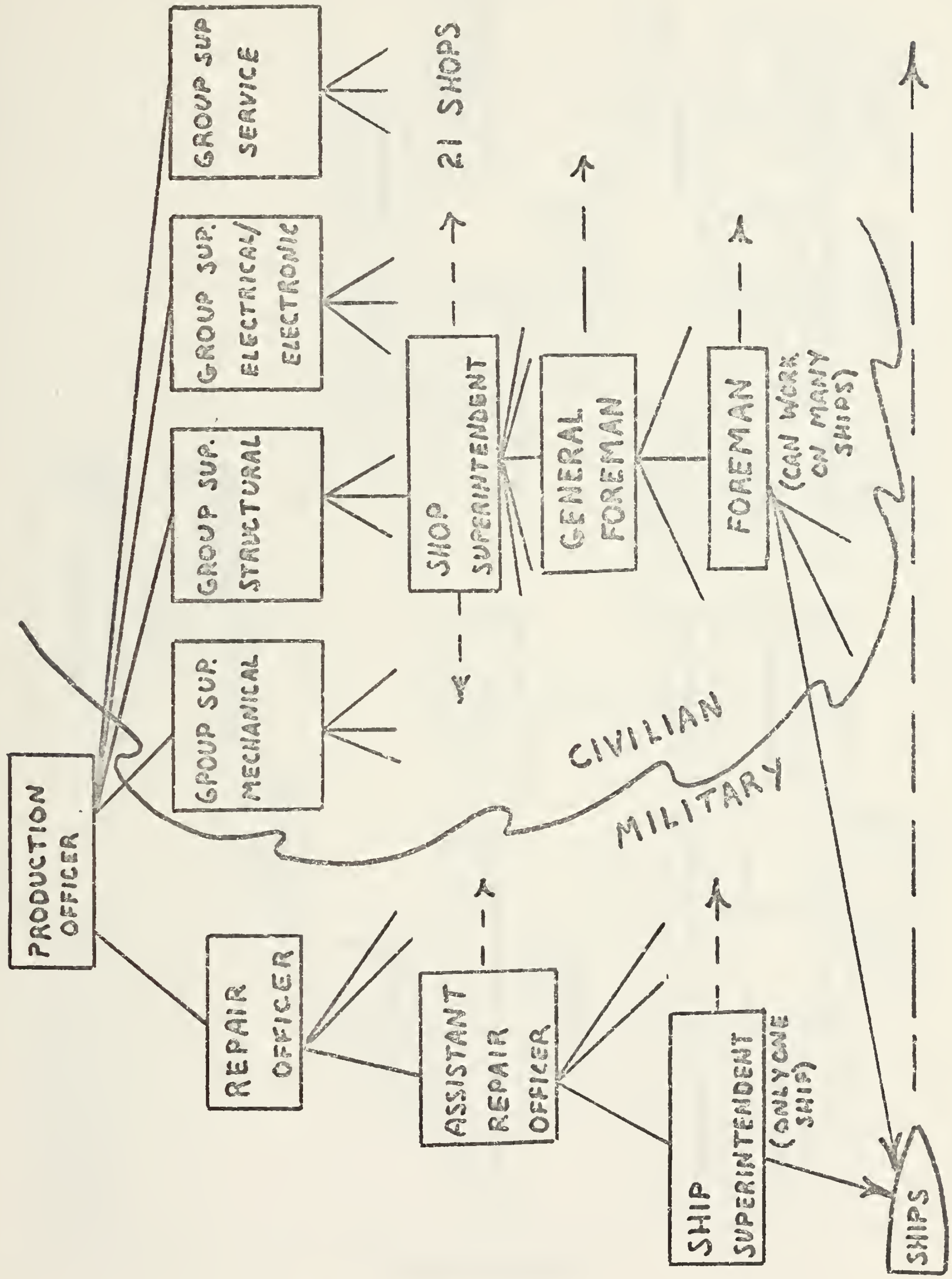


FIGURE III - 3

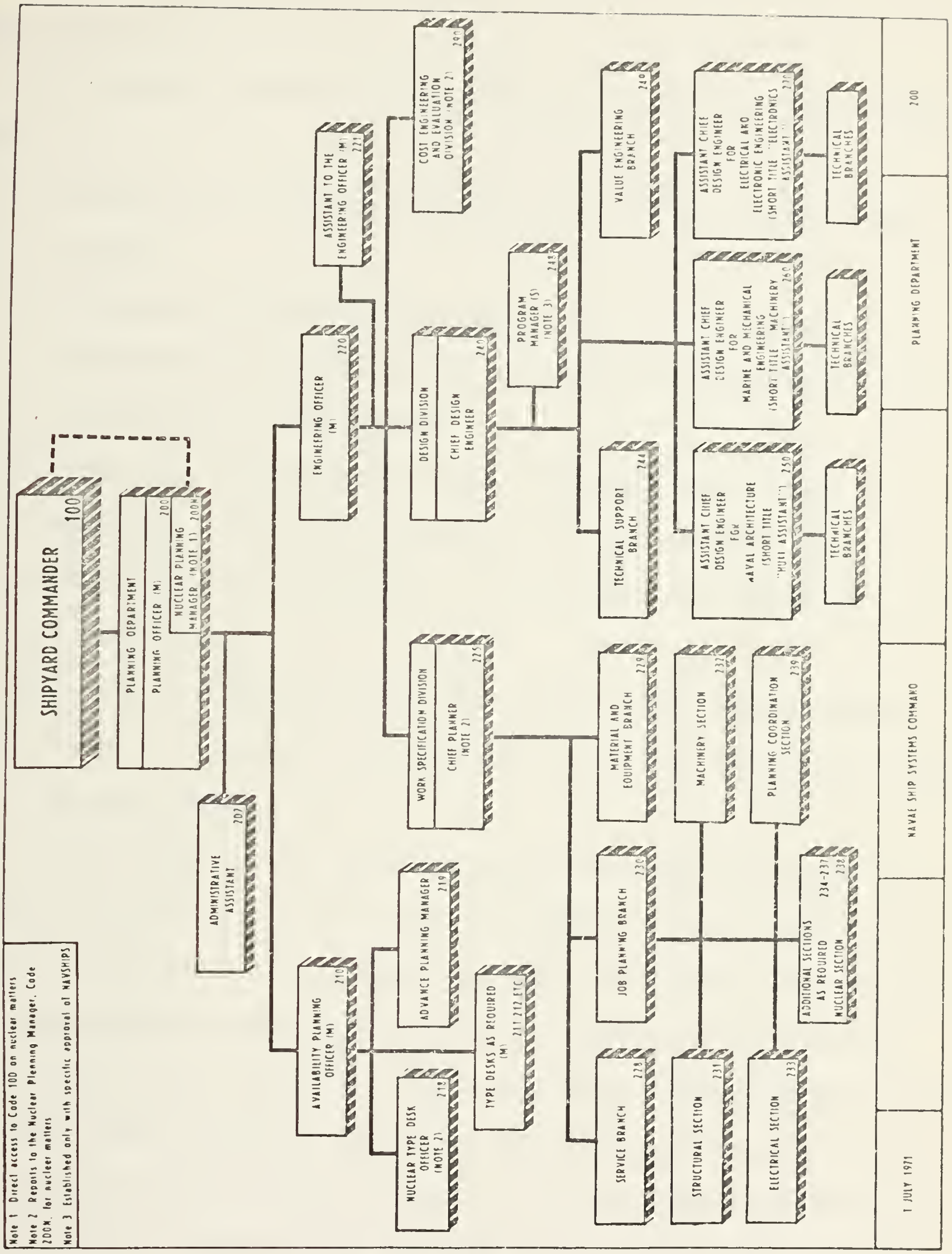

Note 1 Direct access to Code 100 on nuclear matters
Note 2 Reports to the Nuclear Planning Manager, Code 200N, for nuclear matters
Note 3 Established only with specific approval of NAVSHIPS
SHIPYARD COMMANDER 100
PLANNING DEPARTMENT
PLANNING OFFICER (M) 200
NUCLEAR PLANNING MANAGER (NOTE 1) 200N
ADMINISTRATIVE ASSISTANT 207
ENGINEERING OFFICER (M) 220
ASSISTANT TO THE ENGINEERING OFFICER (M) 221
COST ENGINEERING AND EVALUATION DIVISION (NOTE 2) 290
DESIGN DIVISION
CHIEF DESIGN ENGINEER 240
PROGRAM MANAGER (S) (NOTE 3) 243
VALUE ENGINEERING BRANCH
TECHNICAL SUPPORT BRANCH 244
ASSISTANT CHIEF DESIGN ENGINEER FOR NAVAL ARCHITECTURE (SHORT TITLE "HULL ASSISTANT") 250
ASSISTANT CHIEF DESIGN ENGINEER FOR MARINE AND MECHANICAL ENGINEERING (SHORT TITLE "MACHINERY ASSISTANT") 260
ASSISTANT CHIEF DESIGN ENGINEER FOR ELECTRICAL AND ELECTRONIC ENGINEERING (SHORT TITLE "ELECTRONICS ASSISTANT") 270
TECHNICAL BRANCHES
TECHNICAL BRANCHES
TECHNICAL BRANCHES
WORK SPECIFICATION DIVISION
CHIEF PLANNER (NOTE 2) 225
MATERIAL AND EQUIPMENT BRANCH 229
MACHINERY SECTION 232
PLANNING COORDINATION SECTION 239
JOB PLANNING BRANCH 230
ADDITIONAL SECTIONS AS REQUIRED 234-237
NUCLEAR SECTION 238
SERVICE BRANCH 228
STRUCTURAL SECTION 231
ELECTRICAL SECTION 233
AVAILABILITY PLANNING OFFICER (M) 210
ADVANCE PLANNING MANAGER 219
TYPE DESKS AS REQUIRED (M) 211 212 ETC
NUCLEAR TYPE DESK OFFICER (NOTE 2) 218
1 JULY 1971
NAVAL SHIP SYSTEMS COMMAND
PLANNING DEPARTMENT
200

FIGURE III-4

major operation, and will be the basis of the following discussion. The other productive efforts are very similar.

The essential conditions which must exist before an overhaul begins are:

- The ship must be available for the uninterrupted accomplishment of work.
- The scope of the work must be agreed upon by the customer and the shipyard, arranged in order of priority, and specifically authorized for accomplishment.
- Material must be available through the Navy supply system, by purchase, or locally (the shipyard) through the shop stores.
- Sufficient skilled manpower must be available to perform the planned work.

There are three stages of a regular overhaul--the advance planning stage, the short-range planning stage, and the overhaul availability stage.

1. Advance Planning

This stage varies in duration and may extend from as long as 18 months to about two months before the commencement of the actual work performance. During this period, plans progress from a very rough state to a more defined state as decisions are made on contemplated work items, including repairs and alterations. The ship's personnel generate work requests for repair items and they establish the priority for accomplishment of the repair items. The requests are forwarded to the shipyard via the type commander (Commander Cruiser Destroyer Force, U.S. Atlantic Fleet is an example). It is the type commander that is the "customer" for most repair items. He approves or disapproves the work requests submitted, and he funds

the work from authorized appropriations designated for overhaul and repair. Alterations are under the control of the various systems commands (NAVSHIPS, NAVORD, NAVELEX, etc.). Prior to the overhaul, alterations called for by the Chief of Naval Operations Material Improvement Plan are reviewed, the availability of funds and special material is determined, and a summary of authorized alterations is forwarded to the shipyard by the systems commands.

2. Short-Range Planning

The short-range planning stage varies from six to eight months before the arrival of the ship to the time it becomes available at the shipyard. It is specific rather than broad as in the advance planning stage. Lists of desired repairs and alterations are received by the Planning Department, and planners and estimators for each trade prepare job orders which provide estimates of time, labor, material and the cost of each repair and alteration. Direct labor standards are employed, where they are available, to accomplish this planning. The job orders are broken down into component key operations (KEYOPS) which describe the work elements of the job, which shop or shops will perform the work, and the number of labor hours estimated by shop to be necessary for job completion. Milestone schedules are also prepared. Milestones are major events in the overhaul to which job order and KEYOP completions are tied.

When it is possible, representatives from both the Planning and the Production Departments inspect the ship prior to its arrival at a pre-arrival conference. They check plans, determine what design services and special material items are necessary, and check that preliminary plans agree with the work to be performed. When the ship arrives in the yard, an arrival conference is conducted to discuss the planning package. the ship's force

work plans, and to review the scope, priority and authorizations for each item.

3. Overhaul Availability

The third stage of the overhaul is the performance of the work, and this is the responsibility of the Production Department. The job orders issued are the basis for all work performed, for all material requisitions, and for the allocations of funds. A sample job order is found in Appendix A. At least one day before the scheduled end of the overhaul, a departure conference is held and ship's representatives sign off the outstanding job orders completed. If any work is left outstanding, special procedures exist for settlement. Appropriate dock trials and sea trials are usually conducted prior to the departure conference to demonstrate the overall effectiveness of the completed repairs and alterations.

The above description is an ideal framework. What is already a very complex job shop type of environment is further complicated by the difficulty (if not impossibility) of fully specifying the planned work package prior to the arrival of the ship in the yard. Many items cannot be inspected prior to arrival and the scope of needed repairs is frequently defined on historical data. If the workload on the Planning Department is high, detailed planning and design work (job orders and drawings) can lag and cause disruptions in production. Material needed may not have been ordered with enough lead time, may not have been ordered at all, or may be "lost."

The overhaul and repair of naval ships is therefore a complex task demanding the best of management skills. Timely and accurate information is necessary for all of the management functions.

E. Financial Mechanisms

The heart of the shipyard financial mechanism is the Navy Industrial Fund (NIF). The NIF is a revolving fund established by Congress to provide working capital for shipyard use. Under this program, a cash allocation was made to each shipyard at the time the fund was established. The NIF is replenished by billing customers for work performed, materials supplied, and overhead.

The NIF provides shipyard management with a fiscal environment which closely parallels that of a civilian commercial activity. The profit/loss situation is replaced by variance between predicted end costs and actual costs. The goal of shipyard management is to break even; any variance, whether positive or negative, is applied to the NIF.

In practice, the predicted end cost of a ship overhaul is formulated at a point equating to 45% elapsed time in the overhaul. This fixed price establishes "firm incentives for management to obtain performance within the designated fund limitations, thereby encouraging efficiency and economy."[3] The fixed-price technique, and historical performance create a "buyer-seller" relationship which allows the customer to compare the price of goods and services obtained with similar purchases from other naval shipyards or private industry. This helps provide additional incentive to shipyard management.

F. Implications of Government Policy

One cannot obtain a complete grasp of the inner workings of Boston Naval Shipyard without first considering the effect of governmental policies. It is public knowledge that the yard has faced the prospect of closure for a number of years, and the work force is slowly but steadily being reduced.

These reductions in force (RIF's) have been applied to the other yards as well as Boston, and are consistent with the reduction in ship strength which has accompanied the winding down of the U. S. effort in Southeast Asia.

It is at once clear that the threat of closure and reductions in force have had an affect on the performance of the Boston yard, but just how it manifests itself is not clear. One possible conclusion is that the employees might work more diligently in an effort to make the yard look good on a comparative basis with other yards, but this is tempered by the fact that with the reduction in available ship work, Boston might be the first to go anyway because of its older physical plant (in recent years, some of the naval shipyards have undergone modernization, but Boston was not included). Additionally, reductions in force can only be pursued to the point where overhead expenses make the yard incompetitive. It must also be considered that the RIF's caused the release of younger, junior workers thus causing an upward shift in the average age of a shipyard employee to the present 45 years with attendent problems of productivity, training, etc.

One other aspect of government policy that strongly influences shipyard management is the steady emphasis within the Department of Defense (DOD) for standardization of management techniques. This emphasis within the Navy has resulted in development of the "Standardized" Management Information System for Naval Shipyards. Shipyards, however, have traditionally been allowed to develop and utilize techniques of their own. As the reader proceeds, he will realize that this conflict has resulted in one of the major reasons that the MIS is not effectively utilized in the Production Department. Specifically, MIS was developed for management to control operations at the KEYOP level

and Boston manages primarily at the milestone level.

Finally, there is the political factor. Some feel that the yard has sufficient "friends" in Washington to ensure survival regardless of its performance, while others say these same people are letting them down and allowing other interests to prevail.

G. Current Shipyard MIS

The shipyard MIS is a cost-oriented system developed around three major functional areas of operational control involving the four productive work-associated departments in the shipyard.

Shipyard Departments	MIS Functional Subsystems
Planning, Production →	Industrial
Comptroller →	Financial
Supply →	Material

Each MIS functional subsystem is further broken down into elements called "applications."

MIS Subsystem:	Industrial	Financial	Material
Applications:	Workload Forecasting	Cost	Industrial Material
	Production Control	Budget	Shop Stores
	Production Scheduling	Payroll	Accounts Payable Reconciliation
	Performance Measurement		
	Design		

A brief description of the MIS subsystems and applications follows. Emphasis is placed on the industrial applications since the Production Department was the focal point of our efforts. Sample MIS outputs from the Industrial Subsystem are in Appendix B.

1. The Industrial Subsystem

The Industrial Subsystem is concerned with the planning and scheduling of work, forecasting of manpower and material needs, identification and correction of production-related problem areas, and evaluation of the productive effort. Toward this end it employs five applications:

a. The Workload Forecasting Application provides management with information to help balance the workload. It deals with two requirements: a total man-hour forecast and the distribution of this forecast over time. Inputs to the application include work force, predicted work (forecast over time through the use of historical manning curves), loaded work (i.e., work scheduled and issued against current job orders) and expenditures. Output reports indicate what the anticipated shipyard workload will be, by ship and by shop, and force distribution reports indicate man-day expenditures and compare current manning information to forecast figures by ship and shop. This information can be used by management to accept/reject additional work, reduce or increase the work force, arrange for loans/transfers between shops, and allocate leave.

b. The Production Control Application is concerned with control of productive work. Inputs into the application include scheduled shop manpower loading information, daily direct labor and overtime expenditures, labor estimates, authorized work, scheduled and actual dates for all customer and job orders, and associated key operations (KEYOPS). The output

provides information concerning KEYOP and customer order status. The application is intended to assist shipyard management in monitoring KEYOPS which are scheduled to start, scheduled to complete, and are above or below scheduled manpower authorization. Any of these conditions constitutes a "jeopardy" situation.

c. The Production Scheduling Application is based primarily on PERT/CPM methods. Inputs include descriptions of the sequence and scope of all KEYOPS, estimated and actual start dates, and estimated completion dates. PERT/CPM outputs include reports which provide management with network information concerning schedule dates, critical jobs, and potential areas of logic improvement. Actual network diagrams must be produced by manual means. We did not observe the use of this application during our visit to the shipyard; it is apparently utilized only for large complex conversions.

d. The Performance Measurement Application is concerned principally with actual man-day expenditures versus work standards, and the timeliness of job completions. Inputs include scheduled and actual shop workloads, completion dates, job allowances (i.e., standards), and actual expenditures. Outputs conveniently array this data for evaluation of production supervisors and planners.

e. The Design Application is concerned with the status and scheduling of drawings, special projects, test memos and the like associated with job orders. The system contains an inventory of this information with related allowances, expenditures, schedules and status.

2. The Financial Subsystem

This subsystem deals with the flow of funds in the shipyard. It

provides controls over basic system inputs, validates charges to job orders, provides accounting controls over productive and overhead work, and generates shipyard-wide budgeting data. The subsystem has three applications:

a. The Cost Application is concerned with all shipyard transactions that account for cash flow, including amounts due from customers and the dollar value of materials and labor charged to customer job orders. It maintains control over errors that enter the accounting system, validates data on input transactions, and maintains historical data that serve as an effective audit trail and as a basis for predictive cost.

b. The Budget Application deals with the generation of data to budget shipyard workloads with yardwide overhead expenditures. The application generates: labor summary outputs by department; a summary of employee borrows and loans among shipyard shops; leave used, accrued and available; budget estimates for overhead by cost centers.

c. The Payroll Application, besides handling the obvious biweekly payroll, processes all time cards and other cost records. It also computes labor costs for work performed, and monitors employee leave accounts and payroll savings (i.e., maintains a payroll record for each employee).

3. The Material Management Subsystem

The Material Management Subsystem is designed to provide nearly continuous quantitative, financial and status information on industrial materials. Industrial materials are those materials and services purchased with shipyard operating capital provided through the Navy Industrial Fund (NIF). The materials managed may be either (1) "shop stores," which are regularly-used items, (2) "direct material inventory" (DMI), which consists of items ordered against a specific job order for a given ship, or (3) services

(transport, rent, printing, etc.).

a. The Industrial Material Application processes inputs of material requests (via job material lists--JML's), receipts, issues, etc., and provides outputs dealing with inventory, commitments, status and accounts payable.

b. The Shop Stores Application is designed to aid management in its effort to control shop stores material--basically an inventory control problem. The application provides information in the form of shop store catalogs, as well as lists of stock status and projected material requirements.

c. The Accounts Payable Reconciliation Application, as its title implies, reconciles two shipyard accounts: Accounts Payable, into which an entry is made when material is received, and Material-in-Transit, containing entries made when material is paid for prior to its receipt.

CHAPTER III

BIBLIOGRAPHY

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CHAPTER IV.

MODEL-BASED SYSTEMS ANALYSIS APPLIED TO THE SHIPYARD

A. General

Having provided the reader with a brief description of the problem, our intended method of solution, and necessary background information concerning naval shipyards, we are now in a position to proceed with the actual problem solution. In this chapter, the "normative model" of the shipyard Production Department is first presented followed by the "descriptive model." The reader is reminded that the construction of these models was not accomplished in a purely sequential fashion; instead, some descriptive knowledge was required prior to construction of the normative model, and the descriptive model was started prior to completion of the normative process.

The last section of the chapter compares the normative and descriptive models and establishes the system requirements. It can be seen that this chapter is the "Systems Analysis" procedure illustrated in Figure II-5 of Chapter II.

B. The Normative Model of the Production Department

1. Background

The work performed in the overhaul of a naval ship varies from relatively simple tasks such as scraping and painting to complex one-of-a-kind or first-time modifications which require design effort and the co-ordination of persons from several skilled trades. Material must be pre-ordered, it must be there on time, the people with the appropriate skill must be available, plans and drawings must be completed and issued, and

the work must be scheduled in a manner which keeps a balanced work load on each of the shops. The key elements to the successful operation of this complex industrial activity are good planning, scheduling and control. The operation is very similar in principal to the industrial job shop model. This will therefore serve as the base of our "normative" model. The essential elements of the job shop and how they apply to the shipyard and to the Production Department in particular are discussed below. That is followed by several other elements we feel are essential to a good MIS/Control system. The implications of these on decision making will then be considered.

2. The Shipyard As A Job Shop Activity

a. Scheduling

The smoothness of the day-to-day operations in a naval shipyard depend greatly on the effectiveness of the scheduling efforts. The job shop is essentially a scheduling problem. In both cases, the difficulties stem from the unrepetitive nature of the work being performed.

Scheduling in a job shop has three distinct elements. We will call them advance planning, static scheduling and dynamic scheduling. This framework was developed from several readings.

1.) The Framework for Scheduling in a Job Shop

According to Bulkin, et. al.,[1]

"The control of production in job shops can be considered a two-level problem. The first, or macrolevel, consists of balancing the backlog of work and manpower in the shop so as to maintain a level of machine and manpower utilization consistent with the objectives of management.

"...the first problem that must be dealt with is the establishing

of a manpower capacity and work load so as to maintain a desired level of machine and manpower utilization while adhering to prescribed order completion schedules.

"The second, or microlevel, consists of sequencing orders at the functional operation level in a manner consistent with prescribed order completion schedules. Although the sequencing problem exists within the framework of the above problem, it is the crux of the job shop control problem. Without the ability to sequence jobs in the shop in a logical manner, there is little chance that the above objectives will be realized."

The "microlevel" can be viewed as being two distinct steps or stages. Emery has described them as follows:[2]

"The net effectivness of conventional scheduling really hinges on the effectiveness of a two-stage process. Scheduling is the first stage and dispatching is the second. The ultimate test of this system is its ability to meet delivery promises, maintain a low level of inventory, and utilize capacity efficiently."

He differentiates between scheduling and dispatching in the following way:[3]

"It is the function of scheduling to plan in advance the flow of these orders through the shop and to the customer.

"Inherent in the actual running of a job shop is the problem of deciding which order should be given priority when two or more are waiting to go on the same machine. It is the function of dispatching to resolve these conflicts."

According to Rockart,[4]

"...the job shop...(has) two scheduling modes with regard to time: static scheduling, a loading of facilities to some preset limit before the actual day of operation; and dynamic scheduling, a continuous rescheduling of facilities which takes into account the latest events and conditions up to the moment each segment of the schedule is executed."

The necessity for updating the schedule is given by Carroll.[5]

"Because the schedules are issued well ahead of execution, they are subject to prediction errors of two types. First, errors in processing time estimates can result in the infeasibility of the schedule. ...Second, there are numerous events which cannot be predicted as to their average incidence. Among these are machine breakdowns, unacceptable quality performance, worker absenteeism, strikes, lockouts, and acts of God. When they occur, the best laid schedule is no longer valid. Departures from validity naturally increase as time passes after calculation of the schedule, so there is a time-related decay process. When departures have to be made because of decay, they are typically made on the basis of local considerations. The data base defect leading to decay is lack of currency, i.e., failure to update the scheduling model when departures from predictions occur."

The "macrolevel" described by Bulkin, et. al., which is often called "aggregate scheduling," has the characteristics of advance planning. It is the attempt to balance workload and productive capacity. The "microlevel" activity includes Emery's two-stage process. His scheduling

function develops the detailed plan for accomplishment of accepted work prior to commencement of the work. Rockart called this "static scheduling," and we adopt that terminology. Emery's second stage is called dispatching--deciding which job to perform now. This is one aspect of Rockart's "dynamic scheduling." The other is the need to update the original or "model" schedule as explained by Carroll. Dynamic scheduling therefore includes both dispatching and changing and updating the basic schedule.

2.) Application of the Scheduling Framework to the Shipyard

Given this three-stage description of scheduling in a job shop, we will now show how it is applicable to the shipyard.

The scheduling efforts essentially begin up to 18 months prior to the start of an overhaul when the advance planning begins. An effort must be made by the yard to accept a work package that will be within the physical plant capabilities and which will balance the work evenly over time so that each trade (shop) will be fully utilized. The skills required are not such that the yard can hire/fire as a matter of routine policy and underutilized workers cause excess direct labor charges to authorized work issued. Since fixed price contracts are negotiated, such excess charges must ultimately be recouped by an increased overhead rate in order to balance the shipyard NIF (Naval Industrial Fund--see Chapter III for a discussion of the NIF). The first step in scheduling is therefore adequate planning.

The activity of a shipyard is keyed to the detailed scheduling which occurs during the short-range planning phase. The techniques utilized are those commonly found in other job shop environments and include Gantt charting and PERT/CPM. This phase is complicated in a shipyard. Each job

issued by the Planning Department must be considered in two key manners by the schedulers in the Production Department. The Planning Department must ensure that effective sequencing of jobs which are key to meeting the completion date is accomplished, and must also ensure that the work scheduled for a particular shop does not exceed its work force capacity. The scheduler must be both project oriented and work load oriented. This aspect of scheduling can be considered static scheduling--i.e., scheduling for the anticipated work before it commences.

The student and advocate of "Murphy's Law"--"If anything can go wrong, it will!"--would be very content in a shipyard. According to Emery,[6]

> "Deviations in a schedule arise from three basic causes: (1) infeasibility and ineffectiveness of the existing schedule (2) errors in estimating process time (3) unexpected events."

All of these "go wrong" in a naval shipyard for several reasons. Many jobs accomplished in an overhaul cannot be fully detailed until the work begins due to operational use which prevents disassembly and inspection of equipment. Similarly, design changes, customer needs and priorities, funds available, new work requested, changes in the work force and skill levels, breakdown of machines, etc., are all subject to short-term modifications and/or unpredictable (except in a probabilistic manner) occurrences. These real-life issues require that the system provide for dynamic scheduling--i.e., the capabilities to reschedule and to dispatch based on updated current information that reflects the situation as it is, not as it was planned.

We have shown that the shipyard has all of the scheduling problems that are characteristic of a job shop. In the following paragraphs, other

characteristics of a job shop are examined for applicability to the Shipyard Environment.

b. Priorities

Many of the conflicts for skills and materials which must be confronted will be dispatched at the shop/foreman level in making daily work assignments to the mechanics. In order to have some control over this dispatching function and to insure that the assignments are in consonance with upper management desires, there should be some formal or routine manner for establishing priorities of job and project accomplishment. In a job shop, this is typically a rule such as "first in, next up," or work on the task with "earliest completion date," etc.

c. Control--Centralized versus Decentralized

A simple job shop will have a single control point for accomplishing the loading or scheduling. In the shipyard, this is true for the advance planning and static scheduling functions but not for the dispatching function or daily work assignments. Complete central control on a daily basis of each job presently is unrealistic. There are too many jobs issued, too many interactions between shops and skills, too much dependency on material availability, and too much dependency on skill levels and technical knowledge. To attempt to solve these problems by central control, would require implementation of the on-line, real-time information system espoused by Carroll.[7] Although we feel that would be an exciting scheme, it is currently not feasible. The shipyards are in the process of converting to third-generation computers and are using all funds available for this conversion. Thus, we will accept the real world constraint that such a system is several years (at least) away and develop a system which improves the

effectiveness of dispatching and dynamic scheduling. Each shop will require some form of control as will each project. The ideal system will allow conflicts between shop and project to be resolved quickly and at as low a level as possible in the organization.

The latter point is essentially addressing the centralization versus decentralization issue. The central control on a daily basis has already been discussed and it was viewed as currently unrealistic. There is another environmental issue that is pertinent. Naval shipyards have historically given operational decision making responsibility to lower level managers. To attempt to supplant this with a system which is computer based and centralized currently would not be accepted. The current MIS system is not well utilized in the Production Department. If MIS is to aid the management process in the future, the current emphasis should be on relatively simple, straight forward information which aides the current decision process. This will gain management's confidence in computer-based systems and allow for future improvements. We feel this is a very necessary step in the evolution of a developing system.

d. Duration of Tasks

Each job performed in a job shop environment requires a unique amount of time. In the shipyard significant steps have been made in developing engineered standards for planning and scheduling purposes; however, as ships get older, skill levels vary, equipment gets modified, and newer equipment replaces old, these standards should be modified based on historical performance. Only if the system permits time and material charges to be honestly and accurately made to the job they are actually expended on will such updating have any meaning; i.e.,--the historical data

must be accurate. Thus, it is realized that the "typical" job shop has relatively well-defined tasks that have known durations whereas the shipyard performs tasks that are less well defined and which have more variation in the time required to be performed.

Each of the above areas demonstrate the applicability of the job shop model to the shipyard. This realization will have certain implications when considering what decisions must be made within the Production Department and at what level. After considering some other elements which we regard to be essential to an effective and efficient information and control system, these implications will be developed.

3. Other Aspects

a. The Control System

The design of an information system must be done in a manner that supports the control system in which the managers must operate. However, the control system itself should be subjected to scrutiny and altered or changed if appropriate. In this case, the adoption of the job shop model implies that the control system needs to be responsive to those situations requiring dynamic scheduling and dispatching, and it should support the advance planning and static scheduling functions. This idea stems from Anthony's[8] definition of operational control as "the process of assuring that specific tasks are carried out effectively and efficiently" which Carroll[9] construes that in the job shop environment, include "the full hierarchy of operating decisions from the aggregate production, inventory, and work force level, to the day-to-day decisions governing the execution of basic production tasks."

Carroll further states:[10]

"What is meant by control is simply obtaining system behavior in accordance with some basic objectives or standards or some predetermined plan. ...The decision-making mechanism receives two basic types of information, namely status measurements of the entities or activities being controlled and goal (or budget, or schedule, etc.) information from higher management levels. It 'integrates' these inputs on some procedure or decision rule and issues a direction or order which prescribes (or effects) the desired behavior of the entities. This 'feedback' loop...emphasizes an important aspect of control, namely that control is both a decision and information process. In discussing the efficacy of a control process one cannot afford to ignore either process."

This supports the idea that the MIS designer is within his bounds to alter and change the control system where necessary. It also indicates that two types of information will be pertinent--"Where am I?" and "Where am I supposed to be?"

Because of the large number of jobs issued and working at any one time, both the MIS and the control system should be most sensitive to those jobs most likely to cause a delay in completion and/or significant over expenditures. The data should not impose any added administrative burdens on the managers at any level, but rather should be a product of routine data collection. Imposing new demands on a manager's time is unlikely to aid the success of a new system or an alteration of an old one.

b. Performance Measurement

A need for an objective criteria to judge performance is apparent. What that criteria should be is not clear at this stage of the

model building. What is clear is that it must not cause managers to behave in a manner inconsistent with the achievement of the shipyard goals and objectives. The major function of such performance measures in a naval shipyard is to tell both internal and external persons when the yard is or is not doing its job. Since managers at all levels will strive to "do their job"--meaning do well on the established criteria--a criteria which makes the manager's goals the same as the shipyard's goals is necessary.

c. Communication

Communication is an all-inclusive term and it has the support of all interested in good management. This point will not be labored upon here but some aspects are considered important. A MIS system must have as a basic purpose the promotion of the communication of good information. Our "MIS" system is thought of as including all forms of communication within the organization. It is therefore within the purview of the MIS designer to consider ways to stimulate and foster the better flow of information of all types--i.e., to strive for improved communication. Our model therefore requires a system which promotes communication up and down in the organization and between units in the organization. Such things as performance criteria should not restrict these information flows. The MIS designer--especially one approaching the problem as we are--must consider communication in the context of how it influences decisions.

4. Implications for the Decision Process

If the job shop is adopted as the appropriate model and the other aspects considered are accepted, some "ideal" or normative statements can be made regarding what decisions should be made and who should make them. We will be considering only the three managers we investigated, so the model

presented necessarily will be incomplete.

The major decisions in the Production Department will center around some aspect of "scheduling"--the advance planning, the static scheduling, and the dynamic scheduling, both rescheduling and dispatching.

The role of the Production Department in advanced planning should be a determination of its ability to perform the work. It must advise the Planning Department (which is responsible for accepting new work) of this ability and what the impacts will be on already-accepted work, stability of the work force, and other special problems. Since many factors will be important in this area which will only come together at the Production Officer level, it is believed that he should be actively involved in this area. Considerations will include current productive work and problems, union relations, hire/fire abilities, training, expected attrition of personnel, historical data on past work, etc. Many pieces of information must be incorporated in the work load forecasting for the purpose of accepting future work and the Production Officer should be involved in coordinating them.

Static scheduling should be quite routine and involve little of the time of the managers with whom this project is concerned. The Repair Officer must be involved in approving major events and monitoring the scheduling function. Two major inputs to the scheduling problem are job orders issued by planning and needing scheduling and work already scheduled. In order that work already scheduled be meaningful, there must be an effective means of monitoring work in progress so that problems can be rescheduled--i.e., there must be a means to insure that work already scheduled is accurate and up to date so that future scheduling can be done reliably.

It is clear then that static scheduling and dynamic scheduling are very

interactive. The Repair Officer and the foremen will be very involved in the dynamic scheduling. The foreman is the man with the most recent and accurate picture of the status of a particular job. When he has problems, he should be able to key some response to determine the magnitude of the problem and its impact on other jobs and on the project as a whole. He lacks the overall perspective but has the detailed knowledge and experience. For the foreman to know if he has problems, he must know when his job is scheduled for completion, what other work is scheduled, and how he immediately interacts with other jobs and shops. Once he determines a problem exists, it is in his interest to insure dissemination of the problem is made to higher level management and that efforts are undertaken to reschedule if necessary. If they are not aware of the problem, the schedulers may continue assigning new work to his area and an even greater problem may ensue. Therefore, there must be a feedback loop enabling dynamic scheduling to occur and it should be keyed at the foreman level. The Repair Officer is responsible for all productive work. Any rescheduling which will affect completion of major events (called milestones--drydocking date for example) should be his responsibility. Similarly, changes with potential impact on the overall completion of a particular ship or which might affect other current projects should involve his considerations. If the rescheduling is likely to impact on future work, the Production Officer must become involved. Ideally, a good control and information system will preclude such an event.

Since the Repair Officer is responsible for all work and since the above scheme calls for problems to be keyed at the foreman level, he needs other information to check work status. There are necessarily (for administrative purposes if nothing else) several management levels between the

Repair Officer and the foreman, and even the best system will likely malfunction due to human frailties. In order to check expenditures and timeliness of completion, a good decision-oriented system will indicate to the Repair Officer when and where a problem exists.

Not all problems to be solved require rescheduling. Faulty or missing material and design assistance required are just two examples of problems which potentially can be solved in the time alloted and with available resources. The control system must allow that this information be made available to the right persons early enough to allow action be taken to prevent serious problems from developing. The foreman will be involved in such situations. This is the dispatching function discussed earlier. The Repair Officer will also be involved, but it should only be in those situations which will jeopardize completions and increased expenditures.

From the above, it is seen that an information system which highlights problems that jeopardize overall schedule completions and/or over expenditures is desirable for the purposes of rescheduling, assigning material priorities for acquisition, obtaining design aid and many other activities. It must supply the appropriate information to the proper manager. It must not supply too much information--the stacked desk problem--or it won't be used. It is not the purpose of the normative model to establish what that information is at each level, but rather to indicate the type and purpose. The details will be developed later.

All three of the managers will be interested in performance criteria. If properly chosen and utilized, they can indicate where more management attention and resources should be expended. They should highlight problems and aid in solving them, and thus contribute to the productive effort.

There are other decisions which must be made and which are not relateable to the job shop model. They are technical, administrative, human relations, etc. These will be observed and categorized but little attempt has been made to make normative statements about them other than for our purposes they are important only where they affected the main efforts of the Production Department.

C. The Descriptive Model of the Production Department

Having provided the reader with our normative model, we now move to the descriptive model of the shipyard Production Department decision processes and environment. The observations and subsequent construction of the descriptive model which follow must be recognized as being incomplete. This condition was dictated by the paucity of time and manpower available to us. However, by using our own knowledge gained from construction of the normative model, and the model itself, we have hoped that utilization of the resources available to us has been nearly maximized. In the construction of the descriptive model, attempts have been made to minimize needless duplication of material presented in Chapter III, but some repetition was necessary to emphasize certain key points. Throughout the observation and descriptive modelling processes, we have attempted to keep decision making and decision-related subjects the focal point of our attention.

As discussed in Chapter II, the observation period covered approximately four weeks, and utilized the data collection form shown in Figure II-6. During the first two weeks, each of us observed two foremen. These foremen were in the mechanical and electrical/electronics areas, and included both those whose primary work was aboard ship and those whose work

was of a nature that piece work was brought to them for accomplishment in a central shop. The Repair Officer and Production Officer were each observed by both authors for a period of one week.

Upon completion of each segment of the observation period, the recorded data was subject to analysis in order to determine the type of decisions made, the frequency of these decision types, and their relative importance for each of the three levels of Production Department we observed. In sections to follow, results of this analysis are displayed and discussed. It is to be noted that the categorization and labeling of the types of decisions made is somewhat arbitrary and not always clear cut.

1. Direct Decision Analysis

a.) The Foreman

Analysis and categorization of the decisions made by the first-line supervisor yielded the following spectrum of major decisions (see Figure IV-1):

Technical and Control

Cost Charging

Material

Coordination (with other shops)

Administration

By far the most important of these decision areas is technical and control. Of all line and staff managers, the foreman is in the unique position of both (1) having a wealth of job-related experience and knowledge, and (2) being in a position to directly and daily translate that knowledge into action. Others possess one of these capabilities but not both. He is continually faced with the problems (requiring decisions) associated with direct supervision of 15-40 mechanics and observation of their work. A

host of technically-based situations requiring decisions arise including:

1.) Technical difficulties on seemingly straightforward jobs;
2.) Interpretation of plans, standards and written procedures;
3.) Validation of the scope of the actual task as opposed to what the job order says;
4.) Progressing the job/overhaul--where do we stand?
5.) Notification of higher authority when a problem situation is evident;
6.) Determination of repair parts needed to accomplish the job;
7.) Determination of when to close out a "key operation" (KEYOP) (a job order or major delineable work task is usually broken down into five to ten KEYOPS; see Chapter III).

Technically-oriented decisions and supervision consume better than half the first-line supervisor's time.[11]

In supporting his technical decisions, the foreman utilizes several sources: plans and blueprints, technical manuals, job orders, milestone schedules (described in more detail later), planners, and his own general knowledge and judgement. This latter constitutes his most frequently used information source, and it is difficult to envision its total replacement by any mechanized methods.

Much of the foreman's time is spent "on the job" providing solutions to technical difficulties on seemingly straightforward jobs; for example, heat exchanger tubes that have become "frozen" in place and cannot be removed by normal procedures. Most mechanics cannot be relied upon to take

appropriate action on their own without further complicating the problem. Many young mechanics may not have had the experience of seeing the particular problem before, and, are therefore unsure of the appropriate solution.

Instructions for the performance of technical tasks are provided to the worker in a variety of forms: plans, written procedures, etc. Often these instructions are of a general nature, which is understandable because it may well be too complicated or expensive to provide exact, detailed instructions for each task. Thus, the foreman must act as an interpreter of these instructions, supplying the additional specific instructions as required. He is a very appropriate person for this task, since he possesses a detailed knowledge of the specific job, the available instructions for performing the job, and a wealth of technical experience.

Because the planner cannot always physically sight each repair job (in this case he is formulating the job order based on a written description of the deficiency), and also because the extent of some problems cannot be determined until the equipment is actually disassembled as part of the repair procedure, job orders as first written do not always reflect the work that needs to be done. The foreman is the liaison or waterfront representative who must decide if the job order as written describes the task at hand. If, in his opinion it does not, he submits a request for revision of the job order. Since this decision is subjective, it is reviewed by higher management in the Planning Department.

The foreman is also in a position to render effective judgement in determining the parts required for equipment repairs. He can physically see the work in question, apply his experience to the mechanic's request for parts and pass the request to planning for action. He should thus be able

to weight the costs of repair or replacement.

Perhaps the most nagging problems to both the foreman and higher level management are the related problems of: (1) What is the progress or status of the job at any instant in time, and how is this expressed; and (2) When is a major problem situation present, and what prior action can be taken to prevent minor difficulties from becoming major problems. The general approach by the foreman to these questions is to make a decision based largely on his experience. Although there may exist more sophisticated approaches, it is probably fair to say that the foreman's is very appropriate and usually reliable.

Many foremen are reluctant to close KEYOPS until after equipment operational checkout, which may occur at a significantly later date than the completion of the work effort on the KEYOP. The rationale employed is that if a problem develops during testing, the foreman needs a KEYOP against which to charge the rework. This was not the intent of the MIS designers who envisioned KEYOP completion as a progress indicator. Although the foreman is supposed to indicate completion of KEYOPS, the MIS allows anyone to do so and this is often accomplished by the Production Control Branch for KEYOPS associated with milestone completion.

The formally promulgated (via job order and various MIS reports) start and completion times of jobs and KEYOPS are seldom, if ever, adhered to by the foreman. This is caused by a variety of reasons including delays in material receipt, problem areas arising on jobs previously thought to be routine, delays in receipt of plans, emphasis on milestone versus KEYOPS management, etc. The foreman does adhere to the broader based but less flexible milestone schedule which is discussed in a following section and the general

routing sequence which is promulgated in the job order brief published by the Planning Department.

The dispatching priority most frequently utilized by the foreman is the shortest due date. Some foremen consider the assignment of overtime to a job an additional indicator of the desired priority of higher management, though this is not its intended purpose (see the discussion of overtime policy in a following section).

In the technical area, and others as well, it must be kept in mind that the foreman may not have the complete picture or perspective, and thus his judgement and decisions must be reviewed by others, but it is vital that he be encouraged to communicate effectively with higher-level management. In our observations, this was not always the case! The significance of this is obvious; if a man thinks he is being listened to and he is contributing, his morale, productivity, etc. will rise, and quite the opposite will occur if he is not.

Cost charging decisions, although they do not take nearly as much time to accomplish as technical, have a significant impact on shipyard operations. Cost charging allocates direct labor to specific job orders, and thus, when summarized, forms a key input to the determination of the cost of an overhaul. The comparison of actual expenditures versus the amount allowed by standards forms one of two criteria used in the Performance Measurement Application of the MIS.

It is the stated philosophy of higher level management that the foreman charge the job honestly; i.e., report via the mechanic's timecard the actual number of man hours it takes to accomplish a given KEYOP. However, it is clearly evident that the typical yard foreman is very conscious of whether

he has exceeded the KEYOP allowance. Individual foremen use a variety of time consuming mechanisms to accomplish this. Where a significant overrun is evident, the foreman usually submits a "revision request" to extend the allowance. Since revision requests are intended for a change in scope of the job only (i.e., five valves need repair instead of the original estimate of three), many of these requests are turned down. Since the Performance Measurement Application computes performance on a percentage over (under) allowance, even where the overrun is small, there is motivation to charge to the large KEYOPS. One very rarely finds a KEYOP which has been under-expended. The effort put forth by the foreman in accomplishing cost charging is to a large extent unnecessary, and detracts from his primary job. In keeping track of actual expenditures, the foreman usually updates one of several periodic MIS reports on a daily basis or utilizes a separate card file system or a "black book." In some cases, almost a full hour each day was utilized for this useless record keeping.

The current system does not allow the foreman to charge clearly obviously overhead work (such as receipt, handling and processing of repair parts belonging to several job orders) to an overhead account. As a result, we observed numerous examples of overhead work being charged to direct labor.

Material decisions form an area where the foreman plays a limited role, yet their impact on the actual accomplishment of work is great. If the required parts are not available, work may be delayed and the ultimate overhaul completion date may be affected in extreme cases. In making many technical decisions, the foreman must know the availability and status of repair parts, and in the determination of whether a part is critically needed, significant technical knowledge is involved. This demonstrates the large amount of

interplay between these two decision areas. The foreman is called upon to determine which parts are required to accomplish a job and whether a part is critically needed; i.e., whether a delay in its receipt will affect the completion date of the job. Once this information is passed to higher authority, the foreman's role is largely passive; the most he can do is reiterate the importance of particular parts in meeting the schedule, and their impact downstream in the overhaul. The foreman obtains material information from the shop planner who largely utilizes standard and local MIS reports.

Relations with other shops and decisions associated with <u>coordination</u> are handled in a variety of ways, depending on the management style of the foreman. Each job order consists of a number of KEYOPS, and similarly each KEYOP is composed of a number of work instructions (called Line Items) assigned directly to individual shops. The shop in whose area the job order principally lies is designated the "lead shop," and in a similar manner, the "key shop" is designated at the KEYOP level. It is the stated responsibility of each of these designated lead or key shops to ensure that listed assist shops accomplish their work in a timely fashion. The method most commonly used to accomplish this coordination is informal verbal communications. It is clear that tact and skill in manipulating people are essential requirements for successful accomplishment of this task.

The category of <u>administrative decisions</u> is in a sense of a catch-all nature. Administrative decisions include those associated with leave, training, special requests, mechanic evaluations, and the like. Some five to ten percent of the foreman's time is involved in this area which, though it directly detracts from his primary task of on-the-job supervision, certainly

has an indirect affect on the production effort. He must attempt to keep his people happy, yet get the job done.

In some instances, the foreman is called upon to handle situations in which he is not particularly well qualified. An example of this is the handling of drunkenness on the job. Although professional help and formal mechanisms exist for handling extreme and chronic offenders, the foreman must expend some effort in counselling and deciding how best to handle the occasional offender.

In making administrative decisions, the foreman utilizes several informational sources including personal contact and a variety of shipyard instructions and regulations.

A brief summary of the classification of the major decisions made by the foreman is shown in Figure IV-1. Descriptive information flow diagrams relating to this are shown in Figures IV-2 and IV-3.

Adequacy of Supporting Information

The foreman uses a variety of types of information in making his decisions and these are listed in Figure IV-4. In general his informational support is adequate except in the following areas:

Scheduling: As mentioned, the foreman does not usually follow the job/KEYOP start/complete dates as promulgated. Static KEYOP schedules soon fall into disuse and dynamic scheduling is of a partial nature. Milestone schedules are followed and rescheduled when missed, but not all jobs/KEYOPS affected are likewise rescheduled. Dynamic scheduling is of particular importance in analyzing downstream impact of missed milestones.

Priority of Work: This area is in need of some greater degree of formalization. Instances occurred where foremen and shop hierarchy keyed on

MAJOR DECISION ANALYSIS

Management Level: Foreman

Decision Category	Frequency	Importance	Approximate % of Time Spent
TECHNICAL & CONTROL: Are mechanics performing the tasks satisfactorily? What are the solutions to technical problems? Do written instructions need interpretation? Is a revision request necessary? Shall higher authority be notified of current difficulties? What is the progress/status of the job?	Many times a day	1. Most important; only the foreman possesses this expertise; system must be flexible & receptive enough for foreman to exert influence.	50-65%
COST CHARGING: How shall labor be allocated? How does actual expenditure compare to allowance?	Once daily	2. Second in importance. Forms basis for paying mechanic, charging customer & evaluation of performance.	10-15%
MATERIAL: What parts are needed to do the job? What parts are critical?	Depends on job & availability of material. Has influence on at least one decision daily.	3. On same level of importance with cost charging, & can be <u>the</u> controlling item of an overhaul, after determination of criticality, foreman's role is mostly passive.	5%
COORDINATION (with other shops): Are other shops (assist trades) supporting own shop?	Many times daily.	4. Important to keep other shops happy with own shop support work, & also to keep another shop's work from slowing down own shop when lead or key shop.	10-15%
ADMINISTRATIVE: Shall leave be granted as requested? Do people need to be sent to special training schools, and <u>can</u> they be sent? Should personnel loans from other sources be requested?	At least daily.	5. Least important but far from trivial.	5-10%

Figure IV-1

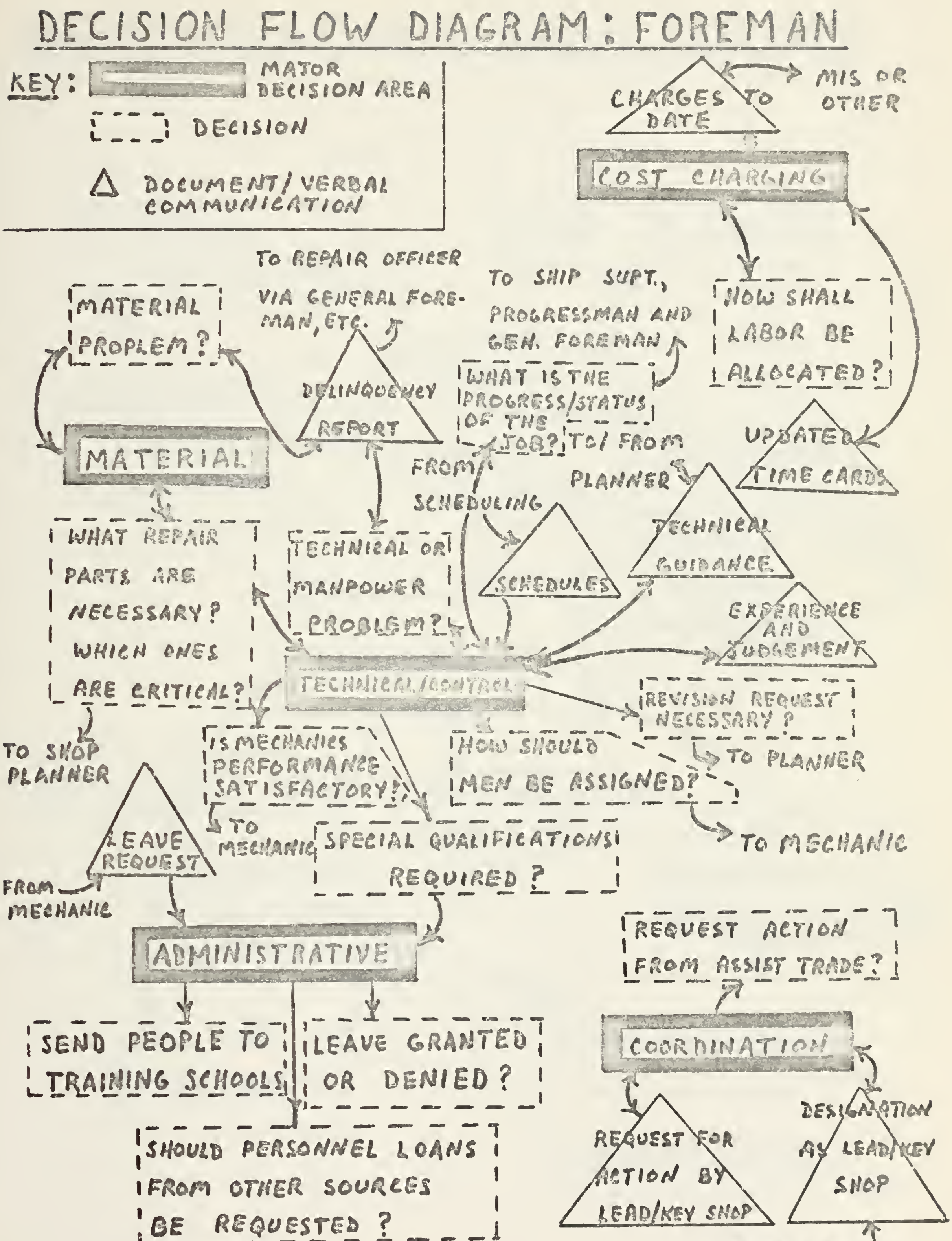
DECISION FLOW DIAGRAM: FOREMAN
KEY:
MAJOR DECISION AREA
DECISION
DOCUMENT/VERBAL COMMUNICATION
CHARGES TO DATE
MIS OR OTHER
COST CHARGING
HOW SHALL LABOR BE ALLOCATED?
UPDATED TIME CARDS
TO REPAIR OFFICER VIA GENERAL FOREMAN, ETC.
TO SHIP SUPT., PROGRESSMAN AND GEN. FOREMAN
MATERIAL PROBLEM?
DELINQUENCY REPORT
WHAT IS THE PROGRESS/STATUS OF THE JOB?
MATERIAL
FROM SCHEDULING
TO/FROM PLANNER
TECHNICAL GUIDANCE
WHAT REPAIR PARTS ARE NECESSARY? WHICH ONES ARE CRITICAL?
TECHNICAL OR MANPOWER PROBLEM?
SCHEDULES
EXPERIENCE AND JUDGEMENT
TECHNICAL/CONTROL
REVISION REQUEST NECESSARY?
TO PLANNER
TO SHOP PLANNER
IS MECHANICS PERFORMANCE SATISFACTORY?
HOW SHOULD MEN BE ASSIGNED?
TO MECHANIC
LEAVE REQUEST
TO MECHANIC
SPECIAL QUALIFICATIONS REQUIRED?
FROM MECHANIC
ADMINISTRATIVE
REQUEST ACTION FROM ASSIST TRADE?
SEND PEOPLE TO TRAINING SCHOOLS
LEAVE GRANTED OR DENIED?
COORDINATION
SHOULD PERSONNEL LOANS FROM OTHER SOURCES BE REQUESTED?
REQUEST FOR ACTION BY LEAD/KEY SHOP
DESIGNATION AS LEAD/KEY SHOP
JOB ORDER

FIGURE IV - 2

INFORMATION FLOW DIAGRAM: FOREMAN

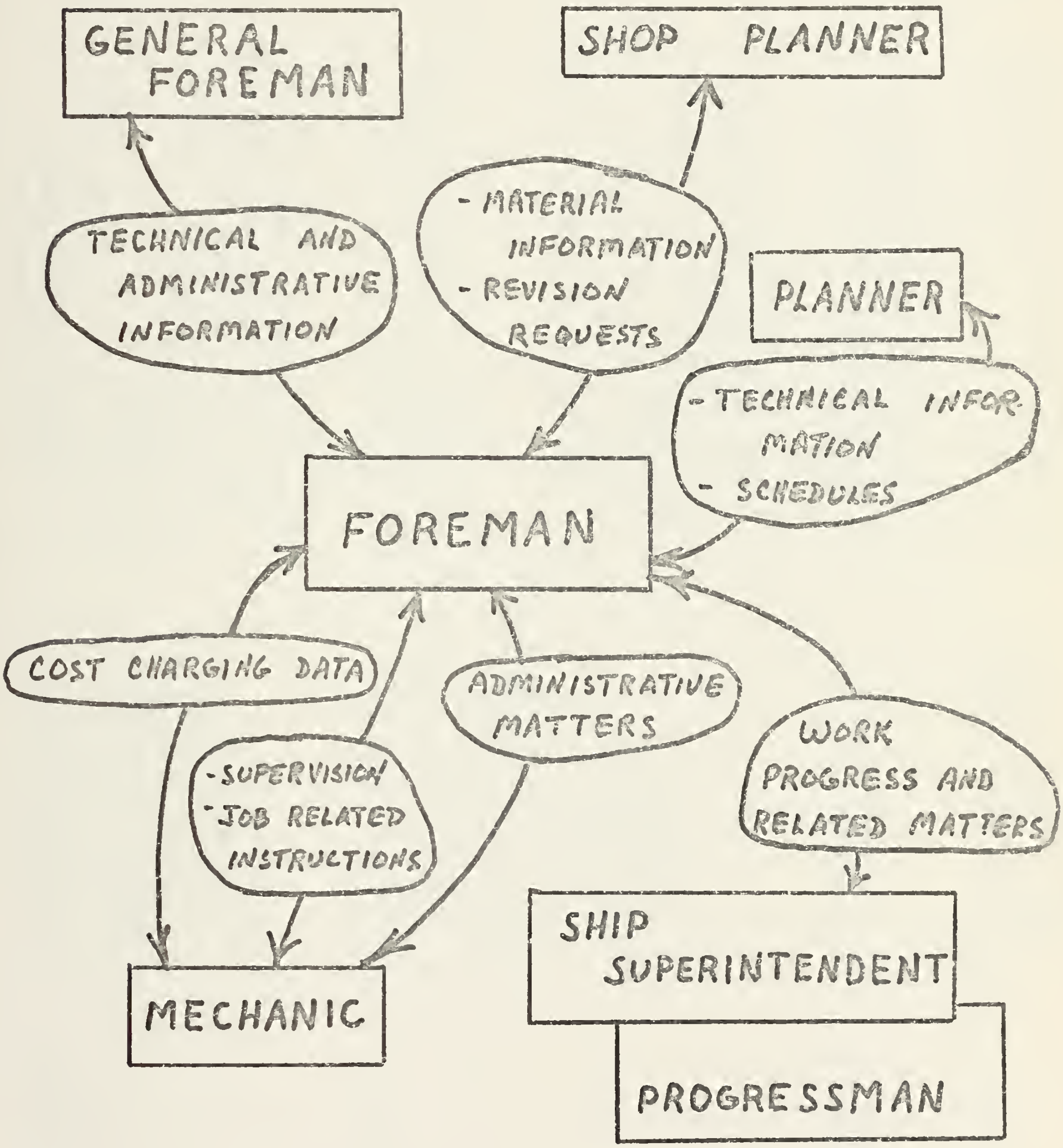

FIGURE IV-3

INFORMATION SUPPORT FOR DECISION MAKING: FOREMAN

Decision Category	Current Information Sources	Types of Information on Which Decision Based	Degree of Support Provided
Technical and Control	1. Plans, technical manuals, job order; 2. Mileston schedule; 3. Own general knowledge & judgement; 4. Planners	1. Mechanic/skill availability; 2. Schedule; 3. Priority of work; 4. Technical knowledge: experience, plans, manuals, communication with designers, planners; 5. Control system: when, how, whom to inform of problem area.	Needs additional support in all areas except mechanic/skill availability.
Cost Charging	1. Labor allowances (MIS); 2. Actual expenditures to date (MIS & own method of keeping "bock" on expenditures).	1. KEYOP allowance and current expenditures; 2. Emphasis of immediate superiors on adherence to allowance.	Inadequate; foreman must keep own records.
Material	1. Material status reports (MIS); 2. Shop Planner; 3. Judgement.	1. Material required (DMI or shop stores); 2. Material status--available? If not, when? 3. Yard capability to manufacture if not available; 4. Time with job delayed if material not received.	Generally adequate, but: (1) Foreman has to get material status info from shop planner; (2) Material non-availability often delays jobs.
Coordination with Other Shops	1. Job Order 2. Personal contact	1. Job progress; 2. Mechanic/skill availability; 3. Designation as key, lead, or assist shop on job order.	Adequate support.
Administrative	1. Contacts w/mechanics; 2. PP&C Manual, shipyard instructions and regulations.	1. Current work load and manning levels; 2. Administrative procedures and 3. Directives of higher authority.	Adequate support.

Figure IV-4

what turned out to be erroneous possible indicators such as allocation (or the lack of it) of overtime. A clear, periodic statement or restatement of priority ships and jobs is needed and its dissemination must reach the foreman.

Technical (Communication): The communication link between the planner and the foreman formally exists, but frequently proves unsatisfactory for a variety of reasons, most of them related to personalities. As a result, many foremen disregard the planner and his potentially valuable technical contribution, and other foremen decide to do things the way the planner wants without interjecting their own expertise; this can prove detrimental if the planner never gets to physically look at the job.

Control System: A better way of progressing jobs/overhauls is needed. Establishment of a formal dispatching rule might prove beneficial. The foreman must indicate completion of tasks to higher management in a timely manner so that proper control can be exercised from that level.

Cost Charging: Few additional words need to be said about this area. The foreman is spending too much time maintaining hand-kept records he thinks are necessary in view of performance measurement criteria and what he believes higher management wants him to do.

Material: The foreman must now get all his material status from the shop planner. Although he certainly cannot practically utilize material status on all repair parts on a regular basis, it might prove beneficial to provide him current status on critical material on a nearly daily basis.

b.) The Repair Officer

Analysis of the Repair Officer's decisions during the period of observation produced the following general categories (see Figure IV-5).

Overhaul strategy/control

Human resources management

Technical

Work acceptance

Customer relations

Since the primary job of the Repair Officer is to ensure that the overhaul or conversion is accomplished in a timely fashion, it is not surprising that decisions relating to overhaul strategy/control rank highest in importance. The Repair Officer is vitally interested in the status of major jobs in the overhaul and adherence to the milestone schedule, even more so than the foreman, who in addition must worry about the manifold details of getting the work done. A key decision that the Repair Officer must make involves determining what are current and potential major problem areas. The Repair Officer cannot afford to respond to many crisis situations after-the-fact. Their occurrence cannot be totally avoided, but he must constantly be on the lookout for potential crises before they happen. As in the case of the foreman, the questions of how to express job status and the determination of whether it is satisfactory must be answered. This is the area of control which is discussed in a following section.

Another decision of importance involves the determination of strategy and priority. Once determined, this must reach down to the foreman level if it is to be effective. The key jobs on the "hot" ships must continually

be reviewed and understood by the shop hierarchy. During our observations, this was not always accomplished.

The decision of how best to coordinate his efforts with the Ship Management Officer (SMO) (when such a billet is utilized for the management of a specific complex or large project, overhaul or conversion) must be made by the Repair Officer. Though his responsibilities are broadly delineated in Shipyard Regulations, in practice the performance of the task depends largely on the personality and management style of the appointee.

Information sources used in the development of overhaul strategy are numerous. The Assistant Repair Superintendents and Ship Superintendents are the Repair Officer's prime suppliers of status information and contribute significantly to the problem-finding effort. Generation of the "Production Officer's Weekly Status Summary" (discussed in detail in a following section) causes considerable effort to be expended and probing questions to be asked in these areas. The availability schedule (a bar-type chart depicting the availabilities of ships currently in the yard and those due to arrive in the near future) and the milestone schedule are relied upon heavily for the development of overhaul strategy. Finally, the Repair Officer must rely significantly on his experience in accomplishment of this task.

The Repair Officer is deeply involved in human resource management. He must make decisions on a variety of related subjects including: coordination and resolution of problems among the shops; allocation of overtime; determination of whether outside contractors should be brought into the yard for specific jobs; comparison of actual manning versus forecasted and determination of consistency with overhaul priorities; determination of whether to complete minor work items at another facility (Newport, R. I., for example,

the homeport for many ships overhauled at Boston); evaluation of requested borrows/loans.

Although both the Repair Officer and the group superintendents (see Chapter III for a description of the Group Superintendent) formally report to the Production Officer, there is a significant intereaction between them. Many problems can be resolved via this means of communication and thus eliminate the need to expose the Production Officer to matters that can be resolved at a lower level. It was our observation that the Repair Officer usually approached the group superintendents on these matters, rather than vice versa.

At the present time, overtime management in naval shipyards is a matter under the direct control of the shipyard commanders. As part of an effort to improve productivity and reduce costs, this has been directed by higher authority in Washington. In Boston, the overtime requests originate in the shops, and go through the group superintendents to the Repair Officer. The Repair Officer considers each request and determines the necessity for approval. He then confers with the Shipyard Commander who makes the final approval decision. In order that the Repair Officer be able to make rational recommendations, he must be well informed on the criticality of the requested work for maintaining the ship on its schedule and the extent to which the schedule will be jeopardized if the work is delayed. If the overtime is requested because limited facilities are in high demand, he must know what those demands are and how critical meeting their schedules are. He needs information on skills and manning levels. In order to stay within the acceptable limits for total overtime expended, he must keep track of the expenditures to date.

When control of overtime was first made a direct task of the Shipyard Commander, the Repair Officer was confronted with decision of how to best determine which requests were valid. Some shops quickly adhered to the newer approach toward careful use of overtime. Others continued to ask for unnecessary amounts. In some cases, employees were accustomed to regular overtime and the cutback caused serious problems in their personal financial situations. Once the policy was enforced, a new problem developed. Some shop heads decided their requests would be turned down, even if valid, and they stopped requesting overtime. The Repair Officer then had to be alert to the situation where overtime was needed but not requested. One tool which can be utilized to help detect such situations is comparing the work load forecast with expenditures and manning levels by ship. If the expenditures lag the forecast, a problem may be developing. Other sources of information are the same as used in the normal control process. Administering this function requires that the Repair Officer be up to date on all projects.

Not uncommonly, the Repair Officer was called upon to pass judgement on requests to bring an outside contractor into the yard to perform work. These requests were submitted either because the yard resources in a particular specialty area were fully utilized or because the customer thought he might be able to get more for his money from an outside contractor in a specialty area (the example we observed involved habitability work). Before a decision is made, the Repair Officer must first examine the impact on the shipyard workforce, and specifically possible action that the shipyard labor unions may take. In this area, the Repair Officer relies heavily on the Production Officer's Administrative Assistant who has had experience in these affairs.

Occasionally the customer will request that a ship leave the yard on a specific date which would allow nearly all of the work package to be completed at normal manning rates, but leave some outstanding work to be accomplished. The Repair Officer must decide whether it is more advantageous to increase manning or send workers to the ship's homeport (usually Newport, R.I.).

The first two decision categories are clearly the most important. The remaining three, technical, work acceptance and customer relations are of lesser importance, and a distinguishing of relative importance among them is both difficult and unnecessary.

The Repair Officer's <u>technical</u> decisions are largely supportive of the overhaul strategy and human resource management areas. He reviews and comments on unusual procedures and arbitrates disputes involving differences of opinion between the shops and the Planning Department concerning important technical matters. He ensures that the ship superintendents and assistant repair officers are on top of technical problems by asking probing questions, and he passes technical judgement on their recommendations. In most cases, he is the final authority on resolution of delinquency reports; this may involve both technical and managerial considerations.

The remaining two decision areas closely involve the Planning Department. <u>Additional work acceptance</u> concerns either a determination of whether work requested by the ship/customer is within the original contract (not as easy as it might at first seem), or whether (1) additional work requested for a ship already in the yard, or (2) acceptance of a new ship will delay ship completions. <u>Customer relations</u> involves impacts of these decisions on the customer and a determination of the position the yard will take in light of possible customer reactions.

Purposely not mentioned above in the discussion of information sources is the role of the Production Control Branch. It is not an exaggeration to state that the Production Control Officer is the Repair Officer's single most important informational source. His office handles three key variables of overhaul management--scheduling, workload forecasting, and progressing. These are in fact close to the titles of the three sections in the Production Control Branch (the only exception is the Work Status Section, whose primary task is workload forecasting):

Work Status--accomplishes work load forecasting using historical data and interaction with the Planning Department and shipyard MIS; compares present forecasted manning in order to find problem areas; works on simulation-related problems such as the affect of adding/deleting a ship to the overhaul schedule. This section accomplishes advance planning for the Production Department.

Scheduling--accomplishes the static and dynamic scheduling for the department. It is this section that establishes the start/ completion dates on all job orders prior to issuance, based on job routing information from the Planning Department (static scheduling). Dynamic scheduling is accomplished for (1) approved revision requests, (2) changes in milestone schedules; i.e., dynamic scheduling is not accomplished for single missed KEYOPS or job orders.

Progressing--accomplishes job/overhaul progressing in parallel with ship superintendents.

A brief summary of the classification of the major decisions made by the Repair Officer is shown in Figure IV- 5. Descriptive information flow diagrams relating to this are shown in Figures IV-6 and IV-7.

Adequacy of Supporting Information

The types of information used by the Repair Officer are listed in Figure IV-8. The degree of support was felt to be adequate except in the areas of work load forecasting and job status support.

Job Status: Since the Repair Officer's prime task is one of control and development of an effective overhaul strategy, he must have accurate job status information. Identification of key status parameters and obtaining reliable values for them is of great importance and in need of improvement. As an example, if the foreman does not charge direct labor to the proper job, and indicate timely completion of tasks, related indices of progress are useless to higher management.

Work Load Forecasting: The Repair Officer's interest in work load forecasting is of lesser magnitude than that of the Production Officer, but still significant. His time frame for forecasting and predicted manning involves a closer horizon, and his main uses of the information are: (1) to decide if adequate manning is being spent on a ship; (2) to investigate inter-ship downstream impacts of increased manning; and (3) to determine impacts of increased job acceptance. Increased reliability of predicted manning curves needs to be developed in order for work load forecasting to become a better tool for indicating job status which in turn determines overhaul strategy.

c.) The Production Officer

Other than the Shipyard Commander, the Production Officer

MAJOR DECISION ANALYSIS

Management Level: REPAIR OFFICER

Decision Category	Frequency	Importance
OVERHAUL STRATEGY/CONTROL: What is the status/progress of major jobs and overhauls in general? Where are the problem areas? What are the feasible solutions to these problems? What are the priority jobs/ships? How to coordinate with SMO? What action to take on delinquency reports? Is current manning satisfactory?	At least daily	1. By far the most important.
HUMAN RESOURCE MANAGEMENT: How should overtime be allocated? Should an outside contractor be brought in? Should the overhaul be completed at other than Boston? How do requests for loans/borrows affect overtime and completion date?	At least weekly	2. Clearly the second most important.
TECHNICAL: Which side in the technical dispute is right? Is a procedure unusual enough to require technical review? Is the procedure feasible? Are ship superintendents and assistant repair superintendents on top of overhauls?	Periodically	
ADDITIONAL WORK ACCEPTANCE: Does work requested fall within the original contract? Will additional work delay overhaul completion date? Can another ship be accepted without delaying those already in the shipyard?	Periodically	Roughly the same level of importance.
CUSTOMER RELATIONS: When is the overhaul/availability complete? When can additional work accepted be completed? Does military necessity justify overtime?	Periodically	

Figure IV-5

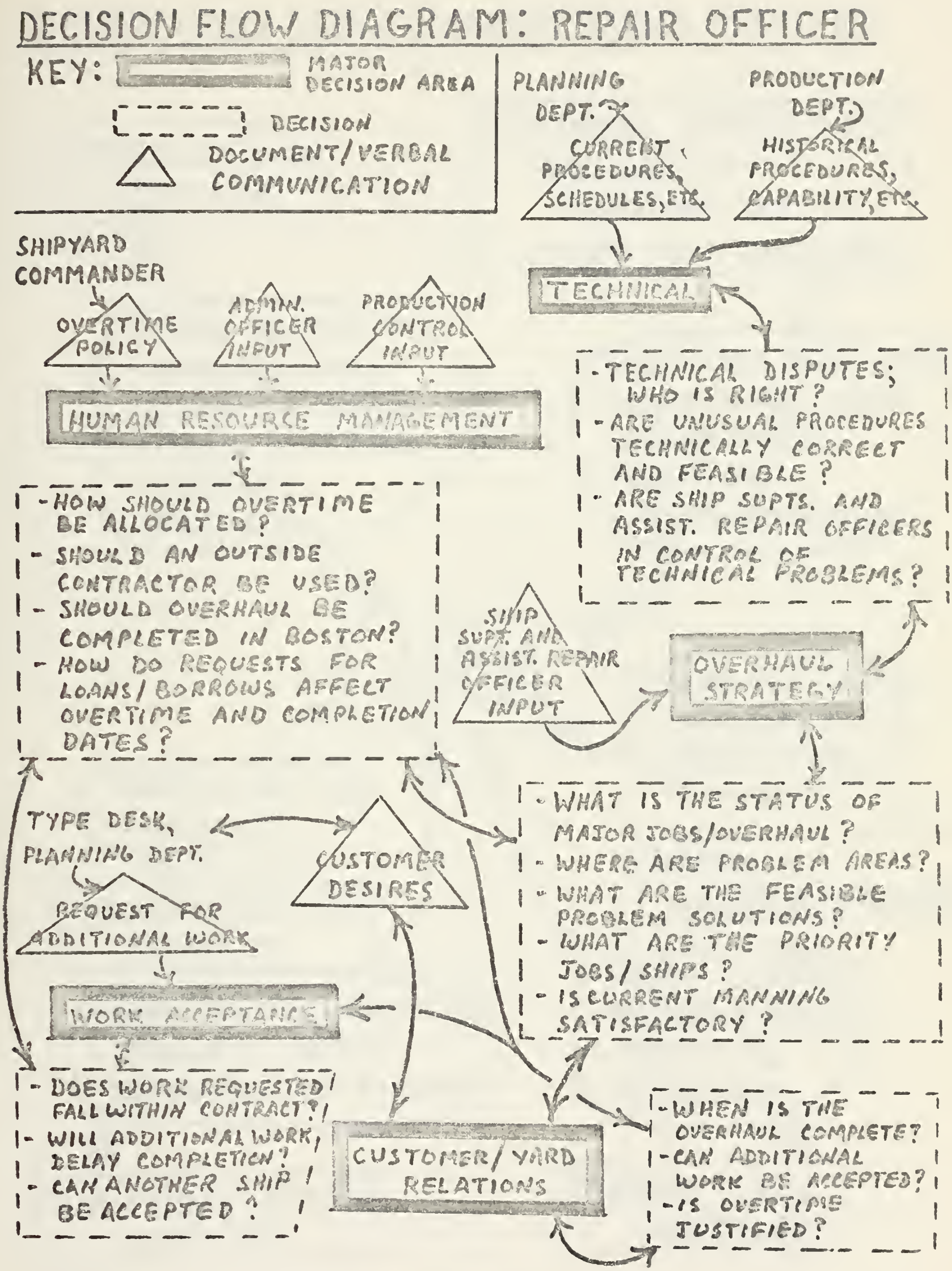
DECISION FLOW DIAGRAM: REPAIR OFFICER
KEY:
MAJOR DECISION AREA
DECISION
DOCUMENT/VERBAL COMMUNICATION
PLANNING DEPT.
CURRENT PROCEDURES, SCHEDULES, ETC.
PRODUCTION DEPT.
HISTORICAL PROCEDURES, CAPABILITY, ETC.
TECHNICAL
- TECHNICAL DISPUTES; WHO IS RIGHT?
- ARE UNUSUAL PROCEDURES TECHNICALLY CORRECT AND FEASIBLE?
- ARE SHIP SUPTS. AND ASSIST. REPAIR OFFICERS IN CONTROL OF TECHNICAL PROBLEMS?
SHIPYARD COMMANDER
OVERTIME POLICY
ADMIN. OFFICER INPUT
PRODUCTION CONTROL INPUT
HUMAN RESOURCE MANAGEMENT
- HOW SHOULD OVERTIME BE ALLOCATED?
- SHOULD AN OUTSIDE CONTRACTOR BE USED?
- SHOULD OVERHAUL BE COMPLETED IN BOSTON?
- HOW DO REQUESTS FOR LOANS/BORROWS AFFECT OVERTIME AND COMPLETION DATES?
SHIP SUPT. AND ASSIST. REPAIR OFFICER INPUT
OVERHAUL STRATEGY
- WHAT IS THE STATUS OF MAJOR JOBS/OVERHAUL?
- WHERE ARE PROBLEM AREAS?
- WHAT ARE THE FEASIBLE PROBLEM SOLUTIONS?
- WHAT ARE THE PRIORITY JOBS/SHIPS?
- IS CURRENT MANNING SATISFACTORY?
TYPE DESK, PLANNING DEPT.
CUSTOMER DESIRES
REQUEST FOR ADDITIONAL WORK
WORK ACCEPTANCE
- DOES WORK REQUESTED FALL WITHIN CONTRACT?
- WILL ADDITIONAL WORK DELAY COMPLETION?
- CAN ANOTHER SHIP BE ACCEPTED?
CUSTOMER/YARD RELATIONS
- WHEN IS THE OVERHAUL COMPLETE?
- CAN ADDITIONAL WORK BE ACCEPTED?
- IS OVERTIME JUSTIFIED?

FIGURE IV-6

INFORMATION FLOW DIAGRAM: REPAIR OFFICER

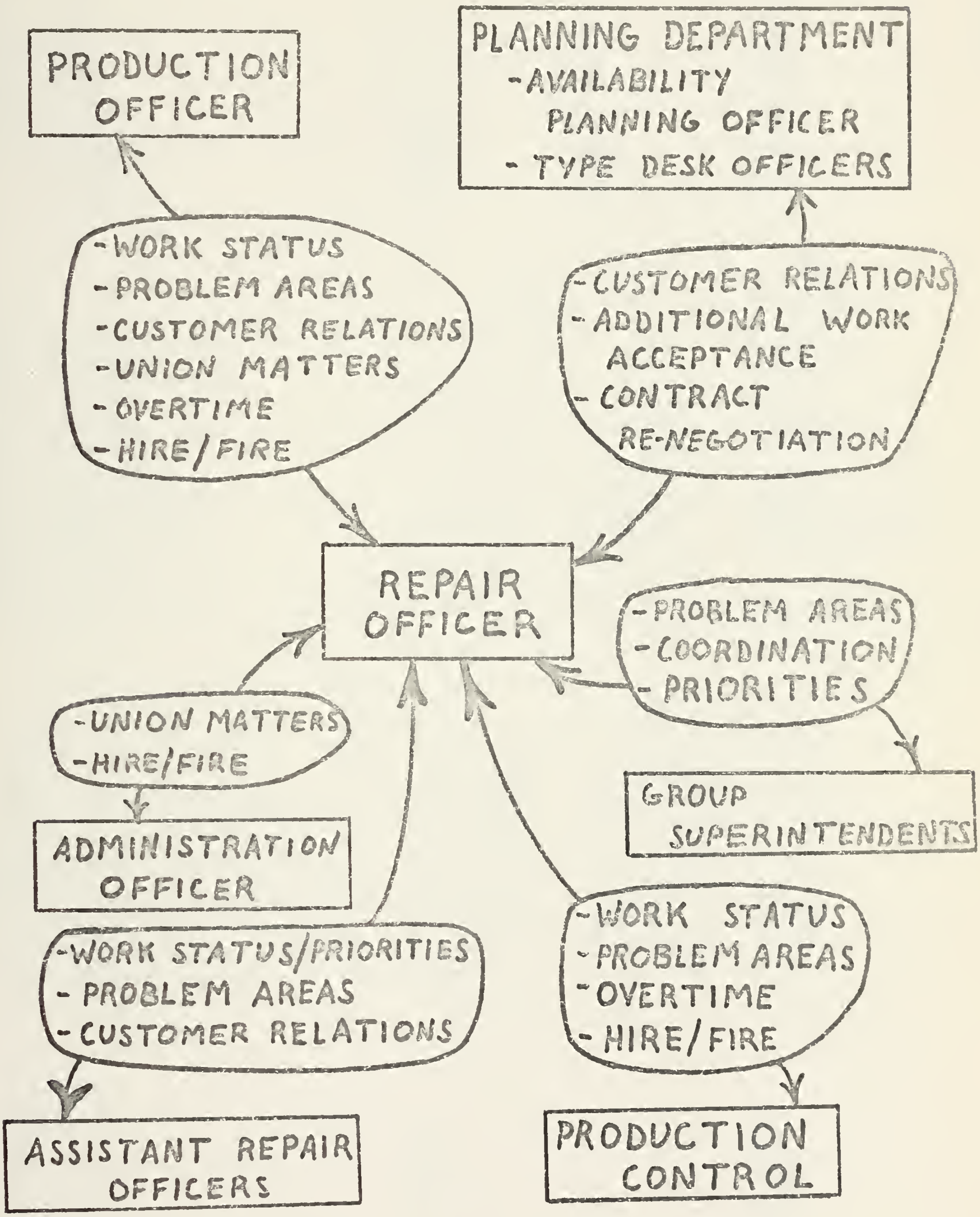

FIGURE IV-7

INFORMATION SUPPORT FOR DECISION MAKING: REPAIR OFFICER

Decision Category	Current Information Sources	Types of Information on Which Decision Based	Degree of Support Provided
Overhaul Strategy	1. Ship Supt. & Asst. Repair Supt. 2. Production Control Officer 3. Shipyard Regulations & PP&C Manual 4. Planning Department 5. Availability & Milestone Schedules 6. Experience & judgement 7. Group Superintendents	1. Work load forecast 2. Current and short-range manning levels 3. Current job status 4. Schedule 5. Customer priority	Workload forecast and job status support can be improved.
Human Resource Management	1. Requests from group superintendents 2. Production Control 3. Admin. Officer 4. Overhaul strategy	1. Same as overhaul strategy 2. Cumulative overtime expended to date 3. Availability of personnel to perform overtime	Same as for overhaul strategy.
Technical	1. Own experience 2. Production Control 3. Personal contact with Asst. Repair Supts. & Ship Superintendents	1. Experience 2. Schedule 3. Historical data of past performance	Adequate support
Additional Work Acceptance	1. Planning Department officers 2. Production Control	1. Scope of work package. 2. Customer priority 3. Manning levels--predicted 4. Current work load and status 5. Schedule 6. Short-term WLF	Adequate except for job status support

Figure IV-8 (page 1)

--continued

INFORMATION SUPPORT FOR DECISION MAKING: REPAIR OFFICER

Decision Category	Current Information Sources	Types of Information on Which Decision Based	Degree of Support Provided
Customer Relations	1. Planning Department Officers 2. Production Control	1. Customer desires and priorities 2. Current job status	Adequate except for job status support

Figure IV-8 (page 2)

is the highest level of management involved in the direct production effort. His involvement in this effort is thus of a more general nature than either the Repair Officer or the Foreman. An analysis of decision areas involving the Production Officer will therefore yield categorizations broader in scope; these include:

Workload forecasting/human resources management

Overhaul strategy

Methods and Standards

Productivity

Safety

Plant facilities

Budget

Personnel evaluation

Workload forecasting and human resource management are the most important decision areas and are considered jointly for the Production Officer because of their close interaction at his level of management. As does the Repair Officer, he depends to a large extent on the Production Control Branch for informational support in this advance planning area. The requirements of the present and projected ship overhaul schedule (obtained from the Planning Department) are overlayed on the current yard workforce, and delineate possible hire/fire actions unless deletions/additions to the work schedule are made. Hire/fire decisions in a naval shipyard are non-trivial matters. Most workmen are at least semi-skilled, and several trades employ skills rarely found elsewhere. In addition, reductions in force (and there have been several in the last few years as the shipyards have declined in workforce numbers) have a significant affect on workers

remaining in the yard. Thus hire/fire decisions require that significant planning effort be expended.

If hire/fire decisions appear to be a likelihood, the Administrative Officer (a civilian with lengthy experience in union/personnel matters) is first consulted. Although the unions in a government shipyard are forbidden to strike, the effects of action taken without proper consideration of union involvement would be readily discernable in the form of decreased productivity and the like.

As the shipyards grow smaller in workforce size, it is anticipated that decisions related to inter-yard and intra-yard borrows/loans will become more important. When unscheduled events such as fires/collisions occur to high priority ships such as aircraft carriers or Polaris submarines, the scope of the work and the shortness of the desired repair time are often such that one yard alone cannot handle the additional burden, however, the shipyards working in concert can. Such a combined effort requires coordination and thorough planning to ensure that the high priority work is accomplished on time without unduly disturbing routinely scheduled work.

An example demonstrating the need for improved resources management occurred during our observation period. As mentioned previously, the age of the average shipyard employee is higher than that found in most firms, and many now qualify for retirement benefits. The way existing benefit statutes are written, it was advantageous for many of the retirees to leave before the end of the fiscal year 1972. However, these people were not required to inform management of their intentions long enough ahead of time so that adequate planning could be initiated to start corrective action. We were told that the same problem had occurred the previous year.

In the area of <u>overhaul strategy/control</u>, the Production Officer, although always involved in a general way, is involved directly only when exceptional situations are present. Ideally, it is the Repair Officer's task to accomplish the productive work effort, but problems arise which must be resolved on a higher level. The Production Officer provides the link between the shops and work load forecasting/human resources management. Additionally, the Production Officer briefs the Shipyard Commander on matters concerning overhaul status and problem areas.

Again, the decision of what constitutes satisfactory work progress arises. Improvement seems to be needed in the area of problem finding and recognition, especially when large or complex overhauls/conversions are involved. During our observation period, the two most significant problems involved large (four- and ten-million dollar), lengthy (six- to ten-month) overhauls of non-destroyer type ships. It seems that special, more formal, and perhaps strictly enforced control procedures are necessary in these circumstances. Once a problem is thought to exist, decision-oriented tools for investigating its validity and providing alternative solutions must be employed expeditiously.

<u>Productivity</u> is a decision area in which the Production Officer has always been involved, but one which is being formally re-emphasized as part of a governmental attack on the problem facing the nation. During our observation period, a program calling for monthly reporting (to Washington) of productivity improvement by the naval shipyards was instituted. The selection of indices used to measure productivity and the generation and implementation of methods to improve performance in this area are very difficult questions to answer. It appears that an increasing amount of the Production

Officer's time will be devoted to this category of decisions.

It might appear at first that the subject of methods and standards is simply disposed of. However, the determination of obtainable, yet demanding, environmentally adjusted (for example outside work in the winter/summer), popularly accepted standards on which to base work expenditure allowances is not so easy. As mentioned previously, the Performance Measurement Application of the standard MIS utilizes the adherence to allowance as an input, which leads to current cost charging practices. The Production Officer relies heavily on the Production Engineering Officer for information in this area. Through this office, attempts are made to standardize work methods and procedures among the ten naval shipyards to provide a means of comparison and more nearly uniform product output.

Plant facilities and budget-related decisions are similar in that they both are periodic decisions requiring substantial prior planning. A special Shipyard Modernization and Facilities Planning Board, of which the Production Officer is currently chairman, makes recommendations for plant improvements and major repairs based on current and future needs and the strategy for shipyard development. The Production Engineering Officer is also the Production Officer's assistant in this area. The budget problem is one of classic nature; the Administrative Officer has a small staff which handles most of this work for the department. It was interesting to observe that these people kept a close watch on the production shops to keep overhead charges to a minimum, including charging some overhead-related items to direct labor, if necessary. This is fine if you want to keep overhead costs down, but it does not reflect true labor charges, makes analysis more difficult, and is not generally accepted as good practice.

Safety needs little discussion. It is trite, but true, to say that safety is everyone's problem. The Production Officer is formally charged with safety responsibility for the shipyard, and has an assistant whose sole responsibility is this area. Occasionally some new and interesting safety-related subjects occur; while we were at the shipyard, approximately 15-20 legal claims against the shipyard for long-term audio damage were filed by current or recent shipyard employees. Hearing losses resulting from a noisy environment is becoming a serious problem to industry in general, and not just the naval shipyards. A practical solution to the problem is not clearly evident, and much work remains to be done before a decision regarding rectification of this problem area can be made.

Personnel evaluation is a decision area in which we did not personally observe the Production Officer, but which was pointed out to us as an important and time-consuming one for him. The Production Officer is responsible for the evaluation of all military officers and many key civilian supervisors assigned to the department, and takes an active part in the preparation of these reports. In this decision area, the Production Officer must have an in-depth knowledge of relevant command policy and the implications of his evaluation on future job performance.

A brief summary of the classification of the major decisions made by the Production Officer is shown in Figure IV-9. Descriptive information flow diagrams relating to this are shown in Figures IV-10 and IV-11.

Types of information on which the Production Officer bases his decisions are shown in Figure IV-12. In general, he is adequately supported, except in the following areas:

MAJOR DECISION ANALYSIS

Management Level: PRODUCTION OFFICER

Decision Category	Frequency	Importance
WORK LOAD FORECASTING/HUMAN RESOURCES MANAGEMENT: How does anticipated overhaul schedule/requirements impact on present workforce? on ships presently in yard? long-term hire/fire decisions; Approve/disapprove inter-yard and intra-yard borrows/loans?	Daily	1. Most important and time consuming
OVERHAUL STRATEGY: When to become involved? How to coordinate between Repair Officer, Group Superintendents and Shipyard Commander? How best to guide the overall productive effort? Where are the problem areas? What are their solutions?	Daily	2. Strong second importance
METHODS AND STANDARDS: Are present standards acceptable? Are standards established by other shipyards applicable to Boston? Are work sampling study results valid and representative?	Daily	5. Medium importance
PRODUCTIVITY: How to measure it? How does one improve it?	Daily	4. Great long-run importance
SAFETY: Are present safety standards being followed? Are present programs satisfactory? How to implement new programs?	Daily	3. In many ways none more important
PLANT FACILITIES: Where to direct the shipyard industrial capability growth? What facilities need improvement/rehabilitation? How much money is needed?	Monthly	6. Long-run importance
PERSONNEL EVALUATION: How to evaluate personnel? How does recognition of exemplary performance affect those not receiving it?	Annually	7. Important
BUDGET: Is department adhering to last budget? Are requests on budget in preparation valid?	Quarterly	8. Least important

Figure IV-9

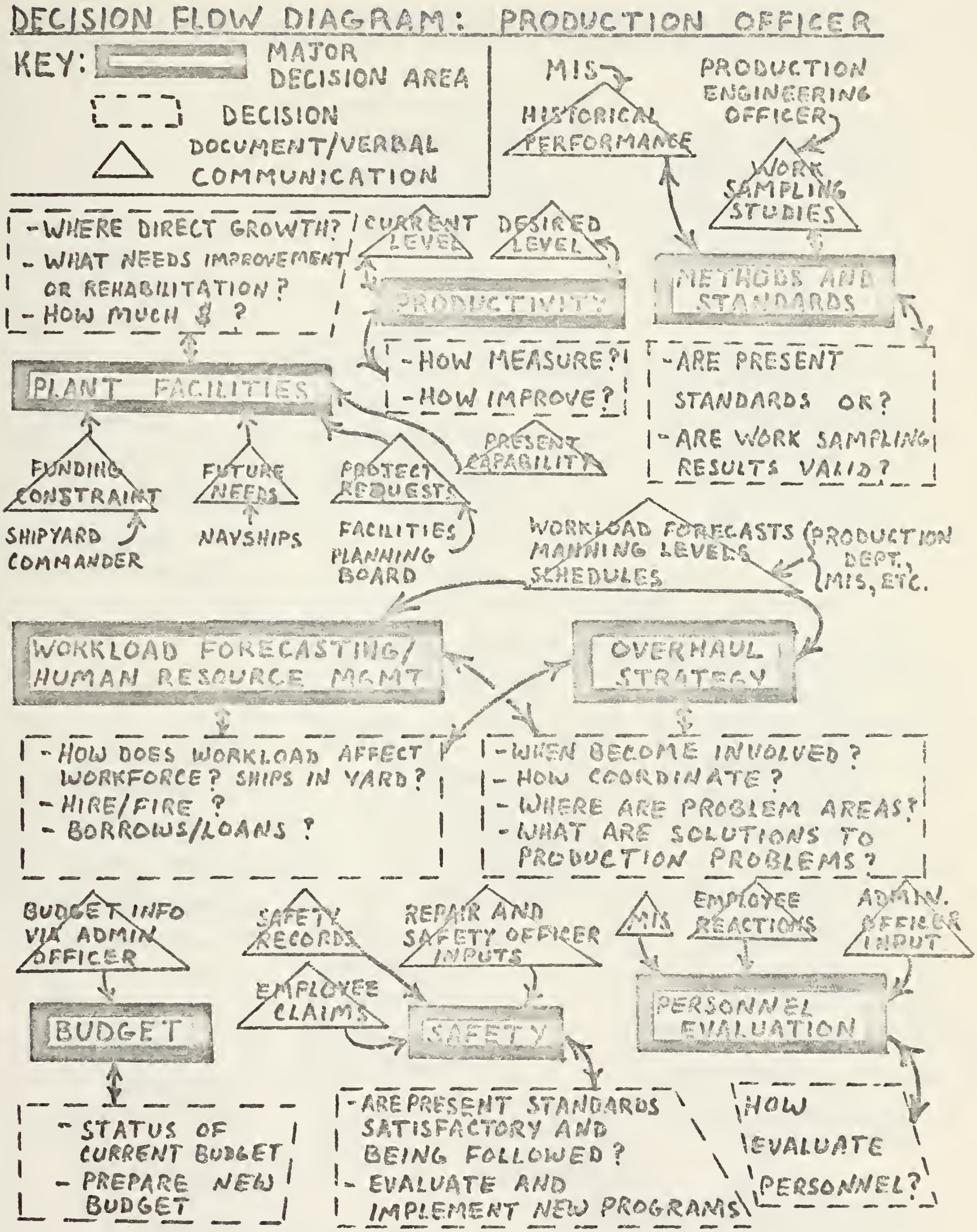
DECISION FLOW DIAGRAM: PRODUCTION OFFICER
KEY:
MAJOR DECISION AREA
DECISION
DOCUMENT/VERBAL COMMUNICATION
MIS
HISTORICAL PERFORMANCE
PRODUCTION ENGINEERING OFFICER
WORK SAMPLING STUDIES
- WHERE DIRECT GROWTH?
- WHAT NEEDS IMPROVEMENT OR REHABILITATION?
- HOW MUCH $?
CURRENT LEVEL
DESIRED LEVEL
PRODUCTIVITY
METHODS AND STANDARDS
PLANT FACILITIES
- HOW MEASURE?
- HOW IMPROVE?
- ARE PRESENT STANDARDS OK?
- ARE WORK SAMPLING RESULTS VALID?
PRESENT CAPABILITY
FUNDING CONSTRAINT
FUTURE NEEDS
PROJECT REQUESTS
SHIPYARD COMMANDER
NAVSHIPS
FACILITIES PLANNING BOARD
WORKLOAD FORECASTS MANNING LEVELS SCHEDULES
PRODUCTION DEPT., MIS, ETC.
WORKLOAD FORECASTING/ HUMAN RESOURCE MGMT
OVERHAUL STRATEGY
- HOW DOES WORKLOAD AFFECT WORKFORCE? SHIPS IN YARD?
- HIRE/FIRE ?
- BORROWS/LOANS ?
- WHEN BECOME INVOLVED?
- HOW COORDINATE?
- WHERE ARE PROBLEM AREAS?
- WHAT ARE SOLUTIONS TO PRODUCTION PROBLEMS?
BUDGET INFO VIA ADMIN OFFICER
SAFETY RECORDS
REPAIR AND SAFETY OFFICER INPUTS
MIS
EMPLOYEE REACTIONS
ADMIN. OFFICER INPUT
EMPLOYEE CLAIMS
BUDGET
SAFETY
PERSONNEL EVALUATION
- STATUS OF CURRENT BUDGET
- PREPARE NEW BUDGET
- ARE PRESENT STANDARDS SATISFACTORY AND BEING FOLLOWED?
- EVALUATE AND IMPLEMENT NEW PROGRAMS
HOW EVALUATE PERSONNEL?

FIGURE IV-10

INFORMATION FLOW DIAGRAM: PRODUCTION OFFICER

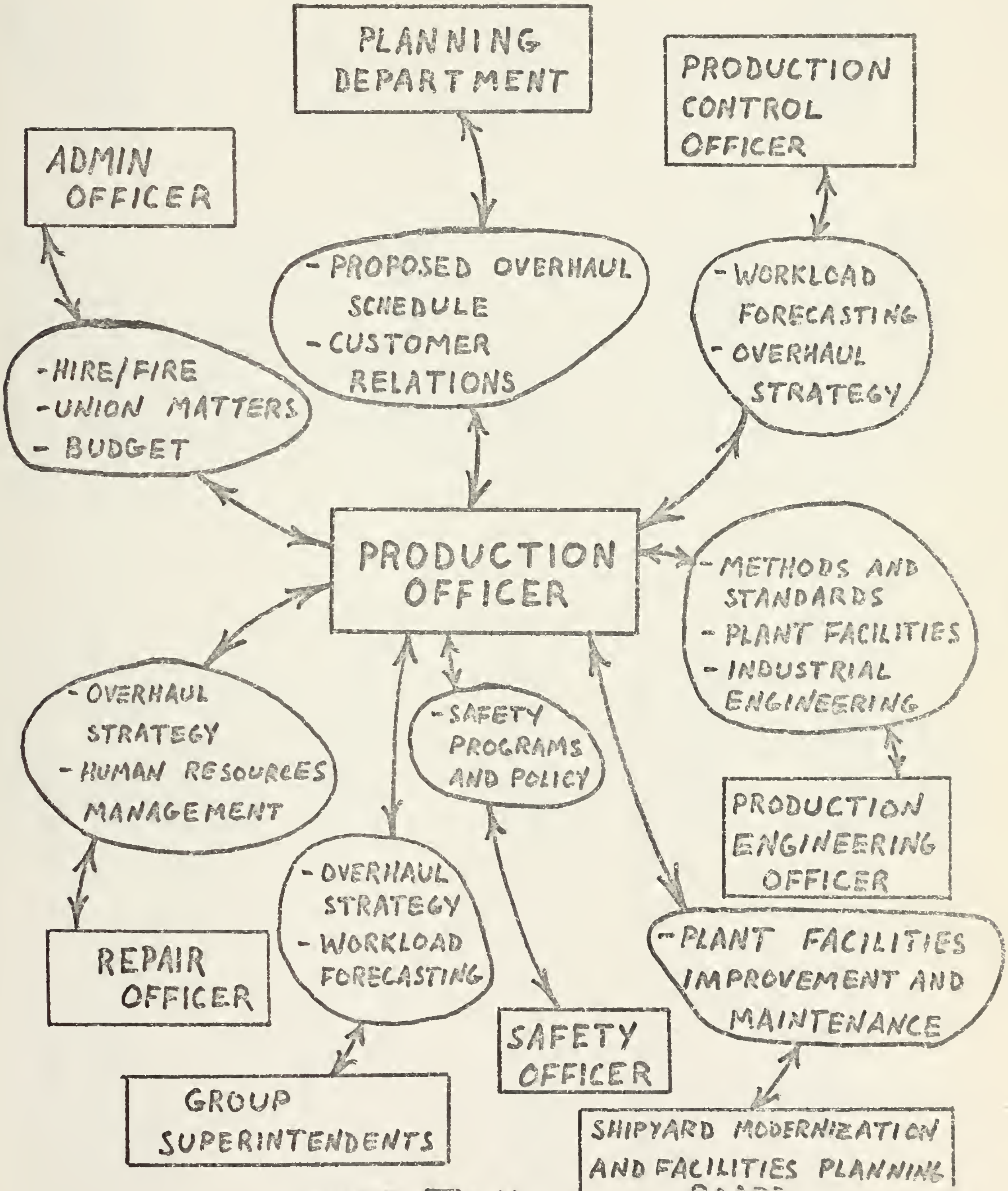

FIGURE IV - 11

INFORMATION SUPPORT FOR DECISION MAKING: PRODUCTION OFFICER

Decision Category	Current Information Sources	Types of Information on Which Decision Based	Degree of Support Provided
Work load forecasting/ human resource management	1. Production Control 2. Repair Officer 3. Admin. Officer 4. Planning Dept. 5. Group Supts. 6. Shipyard MIS 7. Radio messages	1. Work load forecasts 2. Manning levels 3. Schedules 4. Union positions 5. Work status 6. Requirements placed on other shipyards	Work load forecast and job status can be improved.
Overhaul strategy	1. Repair Officer 2. Group Supts. 3. Production Control 4. Shipyard Commander	1. Work load forecasts 2. Manning levels 3. Job status 4. Schedules 5. Customer priority 6. Desires of Shipyard Commander	Work load forecast and job status can be improved.
Methods and standards	1. Production Engineering Officer 2. MIS	1. Work sampling studies 2. Historical performance	Review and updating of standards needed
Productivity	(See discussion)	---	---
Safety	1. Safety Officer 2. Repair Officer	1. Safety standards 2. Current programs 3. Current Safety records 4. Inspections	Adequate
Plant Facilities	1. Production Engineering Officer 2. Shipyard Modernization & Facilities Planning Board 3. NAVSHIPS	1. Future needs 2. Present plant capability 3. Funding constraints 4. Projects requested 5. Evaluation criteria	Production Officer needs analytical method for reviewing priorities.

Figure IV-12 (page 1)

---continued

INFORMATION SUPPORT FOR DECISION MAKING: PRODUCTION OFFICER

Decision Category	Current Information Sources	Types of Information on Which Decision Based	Degree of Support Provided
Personnel Evaluation	1. Administrative Officer 2. MIS	1. Performance data 2. Impact of evaluations on personnel	Adequate (see remarks on performance measurement)
Budget	Administrative Officer	1. Funds available 2. Budget requests 3. Past performance 4. Current expenditures	Adequate

Figure IV-12 (page 2)

Job Status: Comments on job status for the Production Officer are similar to those for the Repair Officer.

Work Load Forecasting: Accurate work load forecasting information is essential to the Production Officer and his staff. Without it, he cannot make meaningful decisions concerning work acceptance, hire/fire, effective manpower coordination between shops and shipyards, etc.

Work Standards: The use of work standards as a management tool is a subject for debate by students of management science and will not be disputed here. If, however, one accepts that standards are in fact to be used, they must be relevant and up-to-date. Cost standards currently in use are ripe for review and validation if not change.

Plant Facilities: The Production Officer needs a method of reviewing or validating priority recommendations of the Modernization and Facilities Planning Board. Capital investment decision tools such as net present value should be employed in conjunction with other techniques.

2. Decision-Related Observations

In addition to directly observing three levels of management in the Production Department, we were also in a position to see how methods were utilized to accomplish and monitor shipyard work. Two of the more interesting and relevant to decision making were the production control system and the use of the current shipyard MIS. These are discussed in following sections.

a.) Control

Control of productive work at Boston Naval Shipyard is interesting to observe. There are three major documents which are important--the job order, the milestone schedule, and the delinquency report.

The job order has been discussed earlier and an example is exhibited in Appendix A.

The milestone schedule is promulgated for each ship availability. Milestones are key events to which job order and KEYOP completions are tied. Examples of milestones are docking and undocking, dock trials, sea trials, etc. A sample schedule is shown in Appendix A. A typical destroyer overhaul will have 20 to 30 milestones schedules. Each milestone has a milestone manager at the shop or group superintendent level who is responsible for ensuring completion as scheduled. Although each KEYOP on every job order is tied to a milestone (labeled KEVENT on the job order), there is no document which tells the milestone manager what all the relevent KEYOPS are for his milestone. He currently relies on his experience and ability, and on the experience of the general foreman and foreman to progress the work and report any problems. If a problem develops which will jeopardize the milestone on-time completion, a delinquency report (DR) which describes the problem is submitted. The method of handling the DR will depend on the type of problem--material, technical, work load, etc. Those problems which cannot be resolved at lower levels go to the Repair Officer. He obtains as much information as he can from the assistant repair superintendents, Group Superintendent, Production Control Branch, etc., to evaluate and determine the appropriate action. He will attempt to hold to the milestone date if possible. If not, a rescheduling of that date, but not of overhaul completion date is tried. If the only solution is to reschedule and delay completion, the Production Officer becomes involved. If the system works properly, the latter will be an infrequent occurrence, except where significant technical or other problems develop.

The main thrust of the above part of the production control effort is through the civilian "line" organization of the Production Department. It can be seen in Figure III-2 that the group superintendents do not report to the Repair Officer. He is responsible, however, for overall management up to the point that unsolvable delays occur. Thus, the effectiveness of this part of the system heavily depends on the personal relations between the four group superintendents and the Repair Officer.

The other major thrust at managing the productive effort is at the Ship Superintendent level. Ship superintendents are relatively junior naval officers with a wide variance of experience in the overhaul and repair of naval ships. Their responsibilities are:

1. Meeting the ship on arrival, seeing that necessary services are provided, calling on the Commanding Officer and heads of departments, and establishing liaison with the ship.

2. Inspecting and coordinating the work of his ship to the end that completion of individual jobs and the entire availability shall meet approved schedules; coordinating shipyard and ship's force work.

3. Advising and assisting senior trade supervisors assigned to his ship; recommending corrective action when, in his opinion, the numbers or distribution of men assigned his ship are disproportionate to the task, or when the utilization or industry of the men is deficient.

4. Ensuring that safe practices are followed in the performance of all work on his ship to the end that casualties to personnel, ships, systems and equipment do not occur; being personally

present for critical events in his ship's availability.

5. Expediting the flow of material to ensure quality and progress is compatible with completion dates.

6. Notifying higher authority immediately whenever he believes that any schedule is jeopardized by factors beyond his control, and when work instructions or plans appear to be in error or when they may be improved.

7. Ensuring that only authorized work is undertaken.

8. Ensuring prompt connecting, disconnecting, and reconnection of services when the ship arrives or is shifted on the waterfront; supervising those preparations for departure for which the Production Department is responsible; and assisting in the timely completion of the ship's preparations for sea.

9. Performing the duties of Ship Safety Officer for his ship when so disignated.

As a matter of good practice, a Ship Superintendent will deal directly with the senior supervisors of the several trades or shops assigned to the ship(s) for which he is responsible, coordinating and assisting them in their relations with other trades, with other shipyard activities and with the ship's force. He shall take direct action with personnel below the level of the senior supervisor assigned to his ship(s) only when such action is immediately necessary to prevent or correct errors, for reasons of safety, or in emergencies; and he shall in such instances inform the senior supervisor as soon as practical of the action he has taken.

It is seen that they have no line authority delegated except in

emergencies. Their effectiveness will therefore depend on their experience and their ability to work with foremen and general foremen, and occasionally with the shop or group heads. To aid the Ship Superintendent there is a civilian counterpart--a progressman--assigned to him. The progressmen have usually had significant yard experience, but their individual abilities vary significantly. The Ship Superintendent performs much as a project manager without authority. However, there is always access to the Repair Officer via the Assistant Repair Officers to resolve problems not taken care of at lower levels. Additionally, there is a weekly meeting of all Ship Superintendents and Assistant Repair Officers with the Repair Officer. This meeting is the start of the preparation of the Production Officer's Status Summary described later in this section.

There are several MIS reports which are thought by some in the shipyard to be of help in locating problems and in aiding the above control scheme. None of the three levels of managers that we observed ever used any of these documents directly to aid him in making a decision. In some instances, there was MIS information presented to them in summary format that had been prepared and "massaged" by staff personnel.

The Production Officer's Status Summary is the key document used for control and progressing of work by higher level Production Department managers. Every Monday, each Ship Superintendent and Assistant Repair Officer prepares a summary of the status of the ship for which he is responsible. A sample is shown in Appendix A. This is reviewed at the afternoon meeting with the Repair Officer. During the remainder of the week, there are various meetings with the Group Superintendents, Production Department staff, Production Officer, representatives of other departments, etc., at which

the information is updated and problems are discussed. The summary sheets provide the focal point of discussion. By Thursday morning, they are updated and the Production Officer utilizes them in a personal briefing of the Shipyard Commander on the status of the productive work. It is to be noted that some of the data used in this report is obtained from the current MIS.

One other document is utilized. If there is a change in the scope of work to be performed (as discussed in the section on the Foreman), a "revision request" is submitted by the shop to the Planning Department. If approved, the job is reissued and rescheduled.

The value of the above system is that it focuses the attention of each key manager on each project for which he has some responsibility. The routine meetings bring them together to discuss and solve problems. The system works and for the past two and a half years has worked well. Prior to that time, Boston had experienced problems with on-time delivery. The milestone system with the emphasis on lower-level management experience was implemented and the record since has been that no delays have occurred except where required by an increase in the scope of the work contracted for with the customer. At the time the new system was started, there was also a change in key Production Department personnel. We heard many opinions on which of these two was most influential in improving delivery performance. Our opinion was that some of both was important. More discussion of the milestone method and ways to improve it will be discussed later. At the current time there are some ship projects in the yard in jeopardy of being delayed.

This control system functions to keep work on schedule. The cost aspect is monitored by the type desk officers in the Planning Department. If

problems occur, the Repair Officer is consulted and the problem is formally addressed. In practice, if all work in the yard is on schedule, the work force is at a proper level, and a ship completes on time without the use of excessive overtime (which is charged to the project actually worked on), there should be no reason for large variances of actual cost from predicted cost.

The control system is very dependent on the expertise of the first-line supervisors. As long as the ship type is familiar and the overhaul is routine, the system should continue to work. As discussed in more detail later, when there are unusual overhauls or extended conversions, it does not function as well.

The system characteristics and performance record are highly dependent on the individuals involved at all management levels. This will be true of any system in the complex operation involved in the shipyard. The best any information system can hope to do is to provide some objective information for the individuals to utilize.

b.) Usage of Current Shipyard MIS in the Production Department

The current usage of the MIS within the Production Department by responsible line and staff managers is discouragingly low. There are three major areas where it is used by managers other than the three we studied. These are described below.

The work load forecasting application is heavily used in the Work Status Section of the Production Control Branch. This is the key point in the yard where the current status is compared with future work to attempt to balance the work load. In actuality, the head of this section normally deals directly with the Planning Department for purposes of determining the impact of

accepting new work. The section also maintains curves and data which help the Production Control Officer, the Repair Officer and the Production Officer in evaluating the status of current work loads. This data is maintained by shop and by ship or project. It helps in determining how far ahead/behind a project is and how over/under loaded particular shops are. The basic type of information compares forecasted loads against expenditures. It is updated so that if scheduled work is not completed, it is reallocated to the time left for the project. The main MIS application utilized is the Work Load Forecasting Application plus some locally (Boston only) developed outputs which utilize the MIS data base. This application is extremely good and has a lot of flexibility. However, it is limited in usefulness for two main reasons. As already stated, the value of the information comes from comparing expenditures to forecasts and both of these pieces of data currently have problems which make them less than precise.

Expenditure information comes from time charging. As previously stated, the Foreman has pressures exerted which cause him to charge less than 100% accurately. If the work has been performed, but by a different shop or shop work center than scheduled, it is not recognized. Additionally, if a job order/KEYOP is not closed out on schedule, and they seldom are (the shops hold them open as "protection" if future work in that area develops), the job then appears as a "backlog," when in fact most if not all work has been performed. There are also problems with the forecast. It is based on work load forecast data supplied to the computer. Each project has a curve prepared and maintained by the Work Status Section. The major source of their information is historical. At the current time, this data is recorded and maintained manually in the section. There are nominally nine or ten

persons in this section and only two of them are free to perform any analytic work--the others maintain and update data. Consequently, the determination and the updating of the work load forecast curves for each project is performed by the two analysts, one of whom is the section head.

The second area is in material control. There is a committee with representatives from each line department which meets daily to take care of material problems. A computer-prepared material jeopardy report is the basic document they utilize. It gives the status of critical material not received. In our study, we did not spend time in this area. However, our time with the Foreman showed that too often material is a big problem and that more might be done to improve the productive effort.

Third is the area of performance measurement. Prominently displayed in the office of the Production Officer are graphs for each of the four groups of their performance. The information is obtained from the MIS Performance Measurement Application. The performance criteria emphasized here is manhours allowed divided by manhours expended. From this level of management, the emphasis against overexpending a job or KEYOP filters down to the Foreman--the manager responsible for daily determination of cost charging. Although it is the expressly stated desire of top management that the Foreman only concern himself with accurate charges, and that he not keep the "little black book" record of his time charges, all four of the foremen we observed did keep his own records and in some manner or other, consciously made incorrect charges. The same was true of the foreman in the course we attended early in the summer. Although the major performance criteria emphasized in daily operations and felt at the first-line level is on-time completions, the performance measurement application, which compares KEYOP

scheduled completions to actual completions, was not observed to be used. This apparently was due to the emphasis on management by milestone rather than KEYOP.

The only use of output from the Production Control Application that we observed was in the Work Status Section which utilized the Direct Labor Analysis Reports for updating the work load forecast and status curves. Some of the status reports were distributed, but we did not observe their usage. The jeopardy reports and KEYOPS scheduled to start/complete reports were not even seen. Again, this is presumably due to emphasis on milestone management, and the reports are based on KEYOP status.

There were two repetitive complaints in the Production Department concerning MIS. The information was considered either inaccurate (see comments above) or too late, or both. It was our impression that most people did not really understand how to use the MIS output format even if the information was accurate and timely.

The relative disuse of the Industrial Subsystem by the Production Department at Boston was considered by the authors to be founded on two main points. First, the management emphasis on milestone management. As long as milestones are met, no one cares or worries about KEYOP starts or completions. The shops are free to do their own scheduling and progressing of work. Secondly, the perceived emphasis and preoccupation at the foreman level on cost charging expenditures and allowances plus the reluctance to close KEYOPS in a timely manner makes the basic progress data input of questionable reliability. In the Work Status Section, we attempted to make our own analysis of a few cases. Our results were entirely different than those of the section head. We took the numbers at face value; he applied

"judgemental" corrections based on ten years of experience to correct for the type of problems that have been discussed.

D. System Requirements

Having presented our normative and descriptive models, the next step in our design process is determination of system requirements. Determining the system requirements is accomplished by comparing the normative and descriptive models. To accomplish this, we must look at the Production Department as a unit to determine overall requirements.

We start with a simple restatement of the key elements of the normative model:

1. Job shop--the applicable model of the production process; characteristics include:

   a. Scheduling--requires:

      1.) Advance planning: Matches resources with work contracted for; should be accomplished by Production Officer and Repair Officer (within the Production Department).

      2.) Static scheduling: Initial detailed scheduling of contracted work; should be accomplished by Production Department staff.

      3.) Dynamic scheduling: Accomplished when changes to static scheduling become necessary; should be accomplished by staff, Foreman, Repair Officer, and when necessary, the Production Officer.

b. Job priority--establishes guidelines for job dispatching within the shop, consistent with desires of higher management; should be accomplished by Repair Officer and foreman/general foreman.

c. Job routing procedure--ensures proper coordination and technical sequencing of complex tasks; should be done by staff Planning Department.

d. Basic scheduling point--in simple job shop ensures maximum utilization of resources; in complex job shop environment, must have inter-shop and intra-shop scheduling points; inter-shop scheduling point should be Production Department staff; intra-shop scheduling should be foreman/general foreman.

e. Wait time--minimized by proper scheduling; accomplished by Production Department staff and foreman/general foreman.

2. Control/Progress Procedures--required for timely accomplishment of productive work; keeps management informed of current status and allows appropriate corrective action to be taken; should be carried out by Production Department managers.

3. Performance Measurement--should be accurate measure of performance and consistent with objectives of higher management.

4. Communication--good communications are essential to work accomplishment in large, complex, long-established industry such as shipyards; important in dealing with technical problems; brings up organizational issues; responsibility lies with all levels of management but especially higher management.

The descriptive observations of the managers, their decisions, and other aspects of the Production Department which are recorded in the previous section, enable us to make a parallel statement of the current situation--or a descriptive model--as follows:

1. Job shop--

    a. Scheduling

        1.) Advance planning--performed by Production Control Branch, especially the Work Status Section; Production Officer involved less than expected; Work Status Section involved in data keeping vice analysis; need for closer high level Production Department/Planning Department coordination appears desirable with the objective of bringing all pertinent information to light, yielding better planning.

        2.) Static scheduling--performed by Scheduling Section of Production Control Branch; effectively accomplished; highly dependent on expertise of present personnel; current application of MIS little used; static schedule rarely followed on KEYOP level, but generally adhered to on milestone level.

        3.) Dynamic scheduling--accomplished only upon submission of revision request or change of a milestone; accomplishment by Scheduling Section; dynamic scheduling incomplete, in that full impact on all jobs is not delineated.

    b. Job priority--no formalized mechanism for establishment of priority exists; generally followed rule for dispatching in the shops is earliest due date (milestone); when accomplished, it is done by Foreman and Repair Officer.

c. Job routine procedure--effectively accomplished by Planning Department; specified on job order brief issued to Production Department.

d. Basic scheduling point--delineation of basic scheduling point effective; on inter-shop level is done by Scheduling Section and on intra-shop level is carried out by general foreman/foreman.

e. Wait time--better control procedures should help minimize present level of wait time; Scheduling Section and foreman/general foreman involved.

3. Performance measurement--emphasis on allowance versus expenditure leads to inaccurate cost charging; emphasis on timely completion of milestones exerts beneficial influence; all three levels of management observed have an interest and are involved in proper performance measurement.

4. Communications--several areas in need of improvement; in particular, communications between foreman and planners/design needs improvement.

The major decision areas which are seen to be in need of improvement are:

Advance Planning

Dynamic Scheduling

Control/Progress

Performance Criteria

Priority

Communications

The information system requirements developed for the Production Department are:

1. Advance Planning:

Develop a computer based historical data bank for past work performed. This should be organized in a manner which will enable the Work Status Section to have easy access to the data for purposes of constructing work load forecasts by ship/project and by shop.

2. Control, Dynamic Scheduling, Performance Criteria, and Goal Congruence: Develop a control system which can be used for large and complex overhauls by:

   a. Establishing a method of progressing a KEYOP, job, milestone and project which will aid the overall control process, especially for large and complex overhauls.

   b. Integrating the above method into a better dynamic scheduling scheme.

   c. Establishing a performance measurement criteria which will be consistent with the department's objectives and which will not motivate the foreman to make improper charges.

All three of these must be approached together to ensure that a workable control system will result.

3. Priority: Establish a method for setting priorities for accomplishment of the productive work.

4. Communication: Improve communications and flow of information between the first-line supervisor in the Production Department and the planners and designers in the Planning Department.

Additionally:

5. The system developed will make maximum use of the existing systems

to accomplish the above goals.

6. An effort to support the decision making of each of the three managers observed consistent with the above goals is necessary.
7. Two other areas in need of improvement and which might be capable of MIS support are the updating and review of methods and standards and in the allocation of funds for plant and facilities improvement.

CHAPTER IV.

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CHAPTER V.

DEVELOPMENT OF THE SYSTEM

A. General

This effort is aimed at developing a system which will accomplish the requirements specified in the last chapter. The overall system is first developed and specified which addresses each of the requirements. The detailed systems to support each of the three managerial levels studied are then developed. The emphasis throughout is on defining what information is required for support of decisions at each level and then ensuring that the required input data is available and can be obtained in a relatively simple manner. It is again emphasized that the overall system is incomplete because of our concentration on only three levels of management. Additionally, unless stated otherwise, we are not deleting the key elements of the current system, such as the Production Officer's Weekly Status Report, Delinquency Reports, etc.

B. The Overall System

1. The Control System and Related Aspects

The current milestone-based system which implicitly gives major responsibility to first-line supervisors for on-time completion was seen to be inadequate for lengthy, complicated or unusual overhauls, but to have posted an enviable two-and-a-half-year record based mostly on destroyer overhauls. The scheme we propose to fill this gap in the system builds on the milestone system and gives management the flexibility of being able to control in more than one manner. It also takes advantage of the current MIS.

a. Proposed Control Scheme

The current system establishes a well planned milestone schedule for each project and designates a particular individual (usually a shop or group superintendent) as the responsible manager for each milestone. There is no formal support provided to aid the milestone manager. As explained earlier, he currently relies on his experience and his subordinates. Each KEYOP on the job order is tied (or keyed) to a milestone (KEVENT on the job order). The MIS system should then be utilized to provide a KEVENT sort which lists all job orders and KEYOPS on those job orders which are keyed to the appropriate milestone. The milestone manager could utilize this to ensure he was familiar with all of the issued work; i.e., as a check list and to aid him in the progressing of that assigned work. This idea--formally aggregating KEYOPS to milestones--serves as the basis for the following system.

For the longer, more complex overhauls, scheduling should include use of PERT/CPM. (The yard has done this successfully in the past and intends to do so for a forthcoming overhaul.) The milestones should serve as the major nodes of attention. The critical path to each milestone should be determined as well as those paths deemed near critical. Appropriate MIS output can be developed which will aid the milestone manager in progressing work along those paths. The main element here is that emphasis is still on milestone management, but that KEYOP control on the most critical paths has become an added feature. If so desired, control by all KEYOPS keyed to the milestone could be attempted. This is not believed to be realistic, however, because of the large number of KEYOPS, many of which are small and have little impact on completion and/or total costs. In addition to

supporting the general control scheme, the link between milestone and KEYOP can be exploited to aid the foreman, and this will be pursued later.

The advantages of the above scheme are:

1. It allows management (Repair Officer or Production Officer level) to determine the method of control for a particular project, or even a portion of a project.

2. The more complex projects can be controlled in a detailed manner on the jobs/KEYOPS which are most important.

3. Only minor changes to the current MIS Industrial Subsystem would be necessary to control at the KEYOP level on the important jobs with the focus kept on meeting milestones. The MIS outputs which would then be of importance would be the KEYOP schedule start/complete, the KEYOP Jeopardy Reports, and the status reports (for samples of the current formats see Appendix B). These formats would be oriented to the milestones.

4. The current workable system can still be utilized where warranted. Even in this situation, the listing of KEYOPS by milestones should be of value at several levels of management.

b. Status Indicators

Currently, one of the major difficulties of the control system and the information system is in determining "Where am I now?" versus "Where should I be now?" The above scheme will aid in solving this problem by providing milestone managers better tools (the milestone-oriented MIS outputs) and by introducing the detail necessary to prevent missing milestones. There are several status indicators which should also be utilized by managers which are based on MIS information. All of the ones we propose are currently found in some form in the Production Control Application, Work Load

Forecasting Application, or Performance Measurement Application. The problems of incorrect cost charging and close out of KEYOPS which affect these measures that were previously discussed, will be dealt with later in this section. Sample output forms are developed later in this chapter.

We emphasize that these indicators will only aid the manager in controlling the productive effort; they will not control it.

The simplest status indicator is calendar days expended versus calendar days allowed. Its significance and limitations are probably clear to the reader who has endured this paper this far and will not be expounded upon.

The broadest, and best, overall indicator is total manhours (or mandays) expended versus total forecast. The appropriate groupings are by total project further divided into shops by project and by total shop. These groupings allow one to progress individual projects and locate shops which are in trouble. This data is frequently most useful in graphical format on a time plot.

There are two pertinent schedule completion indicators--the milestone and KEYOP. At the milestone level, it is appropriate to consider milestones late or rescheduled and the impact on project completion. At the KEYOP level, the indicators are total KEYOPS completed versus total scheduled completed plus the number completed early and the number not completed but scheduled complete. Even though strict adherence to KEYOP schedules may not be required, if KEYOP closeout is done in a timely manner, these would be good general progress indicators.

When the PERT/CPM method proposed above is utilized, the KEYOPS scheduled to start/complete and the KEYOP Jeopardy Report along the indicated paths can be utilized.

Manhours expended versus allowed by either job order or KEYOP is another possibility. We do not recommend its use at the current time, however. This comes too close to performance measurement criteria currently utilized which causes inaccuracies in time charging. Since control is not exercised at those levels, they lose significance anyway.

The above will be of only limited use (as they are now) if the input information is not accurate. Two current problems must be corrected--inaccurate cost charging and untimely KEYOP closure.

The first step to improving the accuracy of cost charging is to eliminate manhours expended versus manhours allowed as a performance or status indicator. There are four situations in which expenditures will exceed allowances. First, is when the job or KEYOP is in trouble and needs extra management and/or technical help. This indicator will detect the problem after it occurs and therefore is not very useful for control. Other aspects of the control system can be utilized to detect such occurrences earlier.

Second, is when there is an imbalance between work force and work issued. Since each man must be charged to a job order so that he will be paid, and since the foreman is so close to the mechanics (for many valid human behavioral reasons), if there is a lack of work available, the pace will slow and the work issued will be stretched until new work is issued or the work force is altered. Again, this criteria of expenditure versus allowance should not be used to detect this situation. Monitoring the work load forecast and work issued versus the manning levels will provide the same information. It will also enable detection in time to take corrective action, rather than after-the-fact.

Third, is when the allowance was incorrect. This does occur and is

information that should be obtained and utilized to update standards.

Fourth, is when a foreman is not doing his job or has problems in his work force. If he has problems, he should be telling his supervisors and they in turn should be helping him solve them. Higher management should not be telling him he has problems. If he is not doing his job, that can be detected in other ways also. The current MIS aggregates this performance measurement by foreman, ostensibly so he can be evaluated individually. Since he controls the input data, however, he also can manipulate it. If he is going to over expend 25 hours on a 100-hour job, he can charge it to a larger job--say 500 hours--where the percentage will be unnoticed, or charge a little to several jobs. Alternatively, he can charge correctly and turn in a revision request to "cover himself" even though he knows it will probably be rejected. Thus, the man not doing his job can take steps to cover up.

Only one of the above uses or situations is seen to require the use of allowance versus expenditures, and that was for updating of standards. It is proposed that this type of data collection be done and utilized for that purpose. It is also proposed that the use of expenditure versus allowance as a performance measurement be stopped. It has no useful effects, and only serves to make the cost charging by the foreman subject to inaccuracies. Additionally, since the foremen perceive this to be important, they waste up to an hour each day keeping records of their charges. This is valuable time that should be spent supervising. Direct efforts are necessary to stop this practice. It is the most time consuming and unnecessary paperwork the foreman performs. Emphasis should be put on making accurate charges.

Deleting the above performance criteria and undertaking an educational

effort to get the foremen to charge correctly and forget keeping their time records should improve the accuracy of the cost charges upon which so much of the MIS is based. We see no meaningful drawbacks to this. Alternate performance criteria are proposed later in this chapter.

The second problem to be corrected is untimely KEYOP closeout. The foremen are reluctant to close them because they will not have a job to charge to in the future if problems occur. Generally, a problem is likely to be discovered during dock trials or sea trials. Therefore, many KEYOPS stay open until the very end of the overhaul. To remedy this, two proposals are considered.

The simplest would be to write a general KEYOP at the end of each job order to "correct all dock trial/sea trial discrepancies." The disadvantage would be that there would be relatively little control of what work is performed against those KEYOPS. That problem already exists, however, and that is not the one this change is attempting to correct. The other scheme would be to establish a team of planners, designers, schedulers and shop personnel that would issue new planning (job orders) in an expedited manner within a reasonable time period (one to two days) after completion of trials. This seems to be an "overkill," but for large ships might be appropriate.

Additionally, management emphasis should be placed on timely closeout. This should be the responsibility of the group superintendents down the civilian line organization.

As a secondary issue, we observed functions performed in the shops which, in our judgement, should be charged to an overhead account. These included such things as receiving and dispatching material (full time for one man in one shop observed), and cleaning and changing chemicals in an acid

cleaning room (about five man days). There currently are no shop overhead accounts established for these types of functions so they are arbitrarily charged to direct labor on job orders. We do not know how extensive this problem is, but feel that management should study this. It appears that the emphasis over the years to reduce overhead has caused many overhead functions to be eliminated, but only in the accounting sense, and not in reality. If this is so, it reduces the accuracy of work status because of the arbitrary way such charges must be made. It also makes preparation and review of the budget difficult. Only if real overhead functions are recognized, can they adequately be controlled.

c. Dynamic Scheduling

As stated in the system requirements, there is a need for an improved dynamic scheduling procedure. One aspect of this is closely related to the control and progress schemes already discussed. If all managers are better able to monitor where the overhauls are, problems will be handled sooner and resolved before rescheduling of milestones becomes necessary. As long as milestone management is utilized, the current methods will be adequate when supplemented with improved status. The weekly meetings and preparation of the status summaries serve as an adequate forum for determining problems requiring milestone changes. The Scheduling Section is then capable of doing the rescheduling and evaluating the impact. For the more complex overhauls, the proposed KEYOP system would require a more sensitive system. All KEYOPS listed in jeopardy must be reviewed by the interested managers (Repair Officer, Ship Management Officer, etc.), and determination must be made as to what needs to be rescheduled and what the impacts will be on the milestones as well as other projects. The actual rescheduling

will again be performed by the Scheduling Section.

d. Performance Measurement

Manhours expended versus manhours allowed has been rejected as a proper performance measurement indicator due to the conflicts it causes with accurate cost charging, and because most of the intelligence it provides can be obtained from other information. In its place, we propose that on-time completion be the major measure in the Production Department. Milestone managers need to be held responsible and accountable for milestone completions. The KEYOP managers likewise are accountable for completion of KEYOPS by the requisite milestone date. If control is on the KEYOPS for designated projects, completion of the KEYOP by the KEYOP date is the appropriate time frame. Secondarily, overtime expenditures versus total manhour expenditures will be used. This information is currently available in the MIS and can be aggregated by either responsible foremen and/or shop.

Using completions as the measure has two main advantages. As stated in the last chapter, the shops are already motivated toward on-time completion of the overhauls and milestones. This scheme would further emphasize this importance. It would also provide impetus to close out KEYOPS when they are completed, making KEYOPS completed a better status indicator for higher level management. Highlighting overtime will result in increased emphasis at all levels to manage within the constraints of available resources.

2. Priority/Dispatching

As pointed out in the normative and descriptive models, it is to be expected that the start/complete schedules as promulgated on the job order will soon after issuing become invalid and not be used in the complex job-shop environment. The next question to address is, "If you do not use the

schedule to accomplish the work, what do you use?" At Boston, the answer most often found is foreman experience, based on milestone dates--an informal closest-due-date approach. It is probably accurate and fair to say that this approach works most of the time. However, in the large or complex overhaul, use of this simple, informal system can lead to problems and misunderstandings; priorities can become confused and critical jobs having downstream impact on overhaul completion can be delayed.

The simplest solution to this problem seems to have two parts. First, a more formal (verbal or possibly written) delineation of priority jobs/ships must be made from the Repair Officer/Group Superintendent level and be reiterated and revised at a frequency to ensure emphasis and to reflect actual conditions in the shop. It is probably best to present this information verbally, since a ship might object to its placement on the priority list if it were to obtain this information. A good time to present priorities might be at the Production Officer's weekly status meeting where the Production Officer, Repair Officer, Assistant Repair Officers, and Group Superintendents are all in attendance. It must be noted that this delineation of priority must reach down the shipyard organization to the foreman (i.e., the dispatcher) in a timely fashion. Secondly, a more formal dispatching decision rule should be evaluated and then promoted, to be used when either lesser priority jobs are involved or current priority delineation is lacking. Adoption of these two practices should eliminate confusion in priorities (for example, the foreman who thought that overtime on a job meant that it had highest priority), and provide a more consistent and sound approach to dispatching lesser jobs.

3. Communications

The primary communication link that must be improved is that

between the general foreman/foreman and planning/design personnel. As discussed previously, current written procedures call for such communication, and for the job to be done correctly and efficiently, there must be effective interaction. The planner (as well as others such as the scheduler, etc.) must know when the scope of the job differs from that promulgated by the job order, and the designer must know when a design deficiency exists, such as an incorrect wiring diagram or plan. On critical jobs, corrective action in response to problem information must be rapid, or job/overhaul completion will slip. The current communications problem manifests itself in several ways: (1) some planners fail to investigate the job by going down into the ship or shop even when the situation on critical jobs warrants it (obviously the planner need not, nor can he physically sight all jobs); (2) some planners are unreceptive to innovative ideas of the foreman; (3) some foremen are guilty of being unreceptive to change themselves; (4) not all design personnel visit the ship for jobs involving installation, relocation, and the like where interference is likely to be a problem (or if they do, you could never tell it from the plans).

More than one possible method of improving communications comes to mind, but the most promising one seems to be the establishing of a waterfront (i.e., near the ships and shops) planning and design coordination office, perhaps integrated with the progressmen. The advantage of this scheme is the rapid response capability it possesses. The obvious disadvantage is the overhead cost of these personnel. However, if the prime tasks of these people were to troubleshoot and refer the problem to the appropriate planner or designer, it would seem that the number of people required would be minimal. Obviously, some sort of cost effectiveness analysis needs to be

applied, but the results might be surprising. The authors believe that waterfront coordinators were at one time utilized in the Boston shipyard, but were eliminated during overhead cost reduction programs. It is our observation that the shipyard is overly conscientious in reducing formally recognized overhead costs, to the occasional detriment of increased direct labor costs and perhaps overall costs. At the very least, adoption of a waterfront coordinator for planning and design should be investigated for large or complex overhauls and conversions.

4. Advance Planning/Work Load Forecasting

The thrust of improvement in this area must be directed toward upgraded information quality, and mechanization of hand-recorded historical data.

Current practices in the work load/manning level prediction area recognize that accurate numbers and curves are not available; for example, the terms "should cost" and "will cost" are in common usage. At the different levels in the management hierarchy, a variety of correction factors are utilized to get the should cost estimate; in some instances, different factors are used for each shop! What is needed is accurate, historically-based information on which to balance work loads between the shops and, over time, to form a vital input to work acceptance decisions, and to act as an indicator of work progress.

Practically all of the historical information of past performance on similar jobs/overhauls/conversions used by the Work Status Section is filed manually. If this information were available in the computer data base, many of the people in the section would be free to devote more time to analysis, which is a key output of their office (if these same people are not of

a calibre to handle analysis, they could be replaced by persons possessing the requisite skills). Until the shipyard's third generation computer is operational, this cannot be accomplished due to equipment limitations.

A final point in the Advance Planning area that must be addressed is the current difficulty in analyzing the impact of possible retirees. As discussed in the descriptive model, current policy does not require that personnel give give sufficient advance notice of retirement for proper planning to be accomplished; this situation is made more serious in that the retiree is financially induced (by the statutes governing retirement benefits) to leave government service whenever the consumer price index passes a certain point, thus causing a step exodus of critically skilled personnel. Despite a declaration by Production Department staff that they had been able to very accurately predict the number of personnel leaving, we observed more than a small amount of uncertainty and anxiety when the increase in the CPI made retirement more attractive. It is clear that the policy should be changed so that workers will be encouraged to provide adequate notice of intended retirement in order that the impact of retiring personnel may be analyzed and a smoother transition effected.

5. Methods and Standards

As pointed out in the descriptive model, work standards or allowances are presently used in performance measurement, work load forecasting and scheduling. Many of these standards are in need of either review or revision. As a result of their not being up-to-date, they contribute to the previously described cost charging practices of the foreman, to the use of correction factors in determining "will cost" and to the general disregard of KEYOP schedules. It is therefore clear that for accurate performance

measurement (even if this is accomplished by comparing gross project allowance versus expenditures), and for valid, relevant scheduling and work load forecasting, work allowance standards must be periodically reviewed so as to be current, obtainable and seasonably adjusted (when applicable), and thus serve to advance management goals and objectives, rather than hinder them.

6. Plant Facilities

The physical plant at Boston is, in general, old and in need of modernization or sometimes extensive maintenance. From the numerous proposals submitted by the shops, the Shipyard Modernization and Facilities Planning Board (via a panel of the same name) approves a list that is within its funding limit; these items are paid for by the NIF and thus ultimately fall into overhead cost. The Shipyard Commander imposes a constraint by limiting the amount of overhead contribution by repairs and modernization. It is clear that a variety of evaluation techniques may be appropriate for determining relative ranking of projects, but during our short observation period, it was not obvious which one(s) the Board and Panel used. However, it seems evident that a cost/benefit-net present value type of analysis is not used, and could be of value as a ranking aid, as well as assist in review of the Board's decisions by higher management. At present, the review procedure lacks analytical capability. The shipyard has access to a program to perform this analysis via a communication link to an externally located computer facility.

C. Support for Each Manager Studied

We adopt the changes proposed in the previous section and apply them in the development of MIS support for each manager studied.

1. The Foreman

The major decision area in which the MIS is capable of supporting the foreman is in his scheduling and dispatching of work to be accomplished. It should emphasize the importance of on-time milestone completions and aid him in accomplishing that task. In order to do this, it should summarize all work for which he is currently responsible and which has not been completed. The use of the computer output should not cause him to perform extra paperwork, and hopefully can reduce some of the current "locally prepared" records and files which are individually maintained. It should help prevent jobs from slipping by--i.e., from being forgotten until a significant problem has developed. Additionally, it should provide some material status for material pre-ordered for a particular job. Most of all, it should be simple and have as little volume as possible.

The output developed is shown in Figure V-1. The first major feature is that the report is prepared for each individual foreman and lists only milestones, job orders and KEYOPS for which he has some responsibility. This requires a new input to MIS which will assign a responsible foreman for each line item issued on each KEYOP and job order. (A line item is each portion of work assigned the different shops and work centers on a KEYOP.) This function is currently performed in a less formal manner. When job order briefs are issued, they are screened by shop staff and/or general foreman and are routed to the appropriate foreman for action. An example of how this information could be input to the data base would add a step to the existing procedure. A set of data cards which contain milestone, job order, KEYOP, line item, shop, and work center already prepunched (this could be done automatically as are time cards) could be distributed along

FOREMAN STATUS REPORT

For: Foreman
Frequency: Weekly

Date of Report: ____________

SHOP _____ WC _____

FOREMAN ____________

SHIP ____________ OVHL COMP __________

MILESTONE ________ COMP __________ MGR __________

J. O. ________ NUMBER ____________

K.O.#	ADHERENCE REQ.	SCHED START	SCHED COMP	MH	KEY SHOP/WC	MATL STATUS
	See Note A					See Note B

Note A: An asterisk (*) means this KEYOP is on a project being managed at KEYOP level and compliance with K.O. schedule is required.

Note B: If material has been ordered against this J.O. or K.O. and is in jeopardy, the printout will refer the F.M. to the appropriate report number and date of the report.

Figure V-1

with the job order brief. When the briefs are distributed at the shop level and foreman responsibility is assigned, the cards could be marked with the name (or a number code) of the foreman assigned. These would then be returned to data processing for punching (same system as time cards) and entry into the data files.

The output would appear so that the projects would be listed in order of completion dates with the earliest date first. All uncompleted milestones for that project are listed by the same date sequence. Each job order and KEYOP on the job order for which the foreman has responsibility is listed, again in order of earliest completion dates. Each KEYOP is supported by a listing of scheduled start and completion dates, manhours issued, and which shop is the key shop. Additionally, they are coded to determine if there are KEYOPS which are on a project controlled at the KEYOP or milestone level. The material status will remain blank unless there is a known problem which is listed on one of the material jeopardy reports which are part of the MIS. In that case, the report number is listed with the report date to enable the foreman to contact the shop planner and get more details if necessary. A blank does not necessarily mean that material is not a problem. At present, shop stores items are not pre-ordered and some DMI material is ordered prior to the issue of the job order. In those cases, a material problem could exist and not be capable of being tied through the MIS or the supply system to a specific job order or KEYOP. Efforts are being taken to remedy this problem.

Deliberately omitted was a space for manhours expended against each KEYOP. This was done to de-emphasize the current foreman preoccupation with this and because it does not provide him with any significant

information. A foreman that needs to look at an expenditure versus allowance to tell him the status of his jobs should not be a foreman. He should know the status from personal observation and supervision.

Using figures available for an outside foreman who had a work force which was twice the normal or average size, the report should be no longer than eight pages. An outside foreman is typically assigned to a specific project. The foreman observed had responsibility for approximately 50 job orders which, at most, would be about 200 KEYOPS. There are 25 informational lines per page in the current MIS output and this therefore would produce an eight-page output. Although these figures are rough, they serve to give an indication of what is likely the largest output to be expected.

The output developed accomplishes the following:

1. It emphasizes on-time completion at the appropriate level (KEYOP or milestone).

2. It provides a checklist for the foreman to insure he has received applicable job order briefs and to establish work schedules and manning assignments.

3. It gives him some advance notice of possible material problems.

4. It eliminates some of the current records or work summaries he presently keeps.

5. It is simple with ample room for him to mark up and utilize as a working piece of paper.

2. The Repair Officer

As a result of the modeling process and delineation of system requirements, it was apparent that the major decision areas in which the

Repair Officer is involved are overhaul control/strategy and human resource management, both of which are closely related. It was also seen that the types of information most in need of improvement were job status and work load forecasting.

In the area of control, we have developed two new computer-generated reports. The first is a ship milestone schedule (see Figure V-2) which would replace the current manually-generated one. The significant advantages of this proposed report are the listing of the responsible milestone manager, the associated job orders, and the respective responsible lead shop. This provides the Repair Officer with: (1) a broadly-based schedule/progress indicator, i.e., the milestone schedule; (2) a reminder of the significant job orders associated with each milestone to help prevent items from "falling through the cracks," and (3) a clear indication of the responsible subproject manager in case problems develop. (A related suggestion, but not in the problem area we defined, is that a listing of KEYOPS associated with each milestone be provided to the milestone manager and/or progressman.) This report should be issued at the start of an overhaul, and when changes/additions occur, but not more often than weekly to prevent unnecessary paper generation.

The second report is a weekly summary of project status indicators to be used in evaluation of ship overhaul progress and as an aid in problem finding. As discussed in an earlier section of this chapter, there is no one clear indication of project status, so we have arrayed the possible best numerical indicators of progress on a single sheet in a manner suited for comparison and analysis. It must be understood that once a potential problem is uncovered, the Repair Officer and analyst will want to consult

MILESTONE SCHEDULE

FOR: Repair Officer

FREQUENCY: Start OVHL, when additional changes made, but not more often than weekly.

Date of Report ____________

		MILESTONE				JOB ORDER		
SHIP	OVERHAUL COMPL. DATE	NUMBER	NAME	COMPLETION DATE	MANAGER	NUMBER	NAME	LEADSHOP

Figure V-2

other informational sources. One of these will be the more detailed information currently available in other MIS reports. Similarly, not all of the valuable progress indicators are presented; for example, the written statement of forthcoming milestones, controlling jobs, and potential downstream trouble areas contained in the Production Officer's Weekly Summary Sheets is excellent and is not intended to be replaced by this array of numerical indicators. This report is shown in Figure V-3.

Two reports were developed in the area of human resources management. The first, the Shop Status Report (Figure V-4) contains no information not already found on standard shipyard MIS reports, but presents information solely relevant to analysis of a shop's current work load vice its capability to accomplish it. The available force capability is compared both to work issued and to the work load forecasted. It will also aid in making decisions on overtime and whether to let work be subcontracted to outside contractors. It is to be noted that the Repair Officer's time horizon for workload forecast information is shorter than that of the Production Officer.

The second report is the Overtime Status Report and essentially mechanizes information currently hand prepared. As discussed previously, the shipyard operates under an overtime quota or target system, and performance against targeted overtime must be monitored. Additionally, the next week's overtime requested from the shops can be compared to that forecasted as necessary by the Work Status Section to meet job/overhaul completions on time. This information is further broken down to the shop level to aid analysis. This report would be issued weekly and cover the current calendar quarter. It is shown in Figure V-5.

PROJECT STATUS INDICATOR SUMMARY

For: Repair Officer
Frequency: Weekly

Date of Report: ______________

SHIP	OVHL COMPLETION DATE	DAYS INTO OVHL/TOTAL DAYS	TOTAL MD EXPENDED/ PREDICTED MD TO DATE/ TOTAL MD FORECASTED	KO COMPL/SCHED FOR COMPL	KO COMPL EARLY	KO PAST SCHED COMPL	BACKLOG*

*Note: Backlog is the difference between allowances and expenditures for jobs which are past their scheduled completion dates.

Figure V-3

SHOP WORK STATUS REPORT

For: Repair Officer
Frequency: Weekly

Date of Report: ____________

SHOP	WORK FORCE LEVEL	MD EXP LAST PD ST/OT	BACKLOG		WEEK: 1	2	3	4	5	6	7	8	9	10	11	12	13
				LOADED													
				WLF													
				AVAIL FORCE													

Figure V-4

OVERTIME STATUS REPORT

For: Repair Officer
Frequency: Weekly

Date of Report: ____________

TGT FOR PERIOD	% OF PERIOD PAST	CUMULATIVE OT EXP MD/% OF TGT		FC OT NEXT PD	OT EXP	1	2	3	4	5	6	7	8	9	10	11	12	13
			Shop ___															
			Shop ___															
			Shop ___															
			Shop ___															
			Shop ___															

Figure V-5

3. The Production Officer

The support developed for the Repair Officer is applicable for use by the Production Officer. Since his perspective is more global and since he is less involved in the day-to-day problems, they will be useful mostly for informational purposes to keep him aware of the current status rather than for problem finding and problem solving.

Two reports have been developed for use by the Production Officer in monitoring and evaluating personnel and shop performance. The Performance Measurement Summary Report shown in Figure V-6 lists each group superintendent and the shops in his group. Performance by number of milestones specifically assigned to each supervisor (all listed by organizational code rather than name) and completed on time is measured for each appropriate manager as well as group totals. The percentage of the total hours that were spent on overtime is also tabulated for each group and shop. This aggregation will allow the Production Officer to view overall performance of the line portion of his department. The report should be issued quarterly.

The summary report does not enable any analysis of what milestones were late or why. The Performance Measurement Report shown in Figure V-7 provides some information which can be of use for that purpose. It lists by group and shop superintendents each milestone assigned and the completion performance on each. The present overtime is tabulated for each milestone. A "remarks" column is provided to attempt to give additional information regarding causes of milestone rescheduling. This report can be used to look at detailed group/shop performance.

This shift to on-time completion as the measure of performance should have some benefits. The entire line organization can stop worrying about

PERFORMANCE MEASUREMENT SUMMARY REPORT

For: Production Officer
Frequency: Quarterly

Date of Report: ____________

MILESTONES

Supervisor	Assigned	Completed on Time	% On-Time Completions	% Overtime*
Group ________				
Shop ______				
Shop ______				
Shop ______				
Shop ______				
Shop ______				
Group Total				

*Note: $\% \text{ Overtime} = \frac{\text{total overtime}}{\text{total hours}} \times 100$

Figure V-6

PERFORMANCE MEASUREMENT REPORT

For: Production Officer
Frequency: Quarterly

Date of Report: ____________

Supervisor	Milestone Ship/Name/No.	Scheduled Completion Date	Completion Date	% Overtime*	Remarks**
Group ________					
Group Supt. ________					
Shop Supt. ________					
Shop Supt. ________					
Shop Supt. ________					
Shop Supt. ________					

*Note: $\% \text{ Overtime} = \frac{\text{total overtime}}{\text{total hours}} \times 100$

**Note: Blank if completed on time.
RESCHED--Rescheduled
RESCHED (1)--Rescheduled due to reschedule of earlier milestone for which not responsible.
RESCHED (2)--Rescheduled due to reschedule of earlier milestone for which responsible.
RESCHED (3)--Rescheduled due to reschedule of earlier milestone for which other manager in same group responsible.
COMP RESCHED--Completed RESCHED ON TIME.

Figure V-7

juggling expenditures to "look good" and can concentrate on doing the job. If the Production Officer and his staff and the Planning Department properly balance the work load and the work force, the expenditures will take care of themselves. If a problem is seen to be developing, the line managers will be motivated more to solve it and to get the job done on time. Additionally, it will cause milestone managers to play a more active role in inter-shop and inter-group coordination since they will realize that they will be accountable for the milestone.

The inclusion of percentage of overtime expenditures provided impetus for the manager to manage within his normal manpower resources. Since timely completion is also stressed the manager cannot act to just ignore overtime. If overtime usage is necessary for completion, he will either ask for it and be on time, or not ask and be late. It will be the responsibility of the Repair Officer and Production Officer to ensure that these performance criteria are properly utilized to direct the Production Department manager's efforts. Inclusion of the overtime emphasizes that it is also important to do the job in an efficient manner--not <u>only</u> to get it done on time.

These reports will aid the aid the Production Officer in objectively making annual performance evaluations of his key managers. They will also aid in finding shops or skills which may be the source of recurring problems and which need special management attention.

Most of the data on these reports is already in the MIS data bank. Assignment of milestones (KEVENT) to a particular manager and the determination of the appropriate "remarks" entry should be the responsibility of the Scheduling Section. They can also prepare the appropriate MIS input for this data.

The other areas of interest to the Production Officer do not appear to us as being capable of direct MIS support. Much can probably be done in the areas of work load forecast (which was discussed earlier), facilities improvement, budget, etc., to aid and support his staff personnel. In some cases, they already are supported by the MIS. We were not able to delve into each of these areas in sufficient detail to make specific recommendations. Given time, we feel that we would be able to do that with the approach we have utilized.

In these areas, the kind of system which the Production Officer could directly use would be one which would enable him to directly interact with the computer and change parameters and get quick output--i.e., to play a "What if?" game. It is unlikely that he would do this with a batch processing system because of the preparation time and the time lag involved. An on-line, real-time system with a terminal easily accessible could overcome these problems. When such a system becomes a real possibility, we feel that the approach we have utilized would be appropriate in determining the system design.

CHAPTER VI

CONCLUSION

The task of designing a model-based, decision-oriented MIS is not a simple one, and the project was indeed a learning process. Additionally, the model-based, decision-oriented method is still a relatively new concept, and before this paper was begun, it was not clear that this approach was practical in the shipyard environment. This chapter is a summary of our evaluation of: (1) the validity of the method, (2) what we have accomplished, and (3) recommended future work. Since we have had no previous system design experience, these comments will not be of a comparative nature, but instead will be directed toward an assessment of the success of the method and the project.

Validity of the Method

The model-based portion of the approach proved to be a particularly useful tool. Construction of a significant portion of the normative model before the descriptive work was started had the effect of forcing us to become generally familiar with the problem early in the process. Similarly, this sequential process helped avert the danger of construction of an MIS based only on the current system. Comparison of the normative and descriptive models highlighted current system deficiencies such as KEYOP versus milestone management, and cost charging practices. Formulation of the final portion of the normative model after the descriptive model was started ensured that the former was feasible and not overly idealistic. Thus, the model-based approach provided an efficient means of defining the existing problem, and it also stimulated the design process by providing ideas for

solution of those problems.

In general, we felt that the decision orientation of the approach was appropriate for the task of improving or redesigning an already existing system. Since we did not attack the problem of original design of an MIS where no formal system existed, we cannot positively comment on its feasibility in this area, but assume that such an approach would be beneficial.

It has been suggested to the authors that perhaps what we should have focused on were specific decisions vice decision areas; i.e., develop a system to support specific decisions. In the shipyard environment, we feel that such an approach would be too idealistic. It was our experience that for (1) the same manager making different but related decisions, and (2) different levels of managers making similar decisions, there was significant overlap in the areas of both the type of information utilized and the sources of the information. In situations where this is the case, it appears to be clear that grouping decisions into categories (decision areas) avoids costly and unnecessary complexity. At the foreman level, the variation in the type of work between shops and between work centers within the same shop would require that a tailor-made system be developed for each. Additionally, individual styles of management would require a change in the system each time there were personnel changes. At the higher levels of Repair Officer and Production Officer, there are a wide variety of decisions. Additionally, the information required for decisions of a similar nature but made at different points in time was significantly different during the brief period we had to make observations. The time and cost involved in developing and maintaining such a system seems to be prohibitive. In an academic sense, such a system would certainly be desirable. In a practical sense, we feel

it would be impossible to attain.

A decision-oriented approach combined with the model-based method provides the analyst with a framework that is sensitive to the prime function of management--decision making. That simple fact helps bridge any communication gap between the analyst and the manager he is trying to support. The managers we worked with were very willing to talk about the decisions they made and how they made them--specifically, what information they utilized and from where and how they obtained it. (An important note: we felt it necessary to actually observe the manager in the process of making the decision and to get his ideas at that time. We feel that an interview or diary approach would not be very useful.)

Assessment of the Project

An objective assessment of one's own work is always a difficult assignment, but one that frequently provides significant benefits. The best way to accomplish this probably lies in trying to answer the question, "Did I do what I set out to do?"

The intent of our task was to design an MIS to support three levels of management in the Production Department of the Boston Naval Shipyard. This we feel we have done. Our finished product constitutes a significant improvement over the previous system, but keeps unchanged those portions which had merit. As the reader will recall, the present MIS is little used by the Production Department, largely due to inaccurate or untimely information caused by improper cost charging and closeout procedures, and differences caused by management by milestones vice KEYOPS (the basis for the current MIS). We have identified the problem areas, recommended corrective action, and proposed a small number of reports that should be useful to

managers in the department.

Was our contention that the model-based, decision-oriented approach lead to large vice incremental changes true? We feel that although the number of reports that have been changed is small, the supporting structure for them has been significantly changed, thereby rendering previously useless reports useful. The establishment of priorities, implementation of proper cost charging procedures and adherence to a modified milestone/KEYOP system are large and basic changes which, if implemented, should go a long way toward making the system usable and effective. We are not sure that these same results could not have been derived by methods other than the one we employed, but regardless, we doubt that others would have done so in as efficient a manner.

In a non-academic sense, the project was immensely successful in two areas; first, it provided us with a "hands-on" experience in the system design area, and secondly, provided an opportunity to view a naval shipyard (our future area of employment) from a vantage point that few naval officers can enjoy. Formal instruction, case studies, and term projects certainly go a long way toward providing the student with a background in information system design, but such an education is not complete without an extensive field experience such as this. While in the shipyard, we were free to investigate what we chose, relatively immune to the daily pressures and biases which beset one permanently employed in the yard, and we were able to view the operations and inner mechanisms of the shipyard in a close to objective manner.

Recommendations

The following are our recommendations for future work that can expand the knowledge of MIS design:

1. Do a study to determine the feasibility of developing a system based on detailed analysis of specific decisions made at each management level. If the study indicates that there is some level of feasibility, utilize that approach in a real situation and evaluate the effort.

2. Study other case situations (i.e., other than the job shop) to see whether the model-based approach can be utilized and therefore developed as a generalized approach to MIS design.

3. Investigate the differences, similarities, and overlap between the decision-oriented and functional-oriented approaches discussed in Chapter II and illustrated in Figure II-2.

4. Expand the dimensions of Figure II-2, especially in the "orientation" direction.

APPENDIX A.

4

EXHIBIT I

Unit 18-R1
MIS-7637
Case

JOB ORDER

SHEET 1 OF

JOB ORDER NO.	SUPPL.	PE	FINAL	M/R	W.R. NO.	PLANNER	EXT.	SCHEDULER	EXT.
16083-208-02	0	N	F		A160 A204	FOX	207	CUMMINGS	219

SHIP/PROJECT	DATE	PRIO	INSP. CL	VAL	CRIT	CHG	LO SH/WC	PE	IO	SCH. I.S.	CODE RTG
AGNU DD831	08061	36 37	1				38	RX		H	232 130-133

MHR EST/ALLOW	LABOR EST/ALLOW	OHD EST/ALLOW	SS EST/ALLOW	MTL EST/ALLOW	TOTAL EST/ALLOW
	1297	1247	—	4000	6544

JOB TITLE	SCHED. ISSUE DATE	SCHED. START	SCHED. COMPL.
#1 & #2 EMERGENCY FEED PUMPS	09-01-1	09-03-1	11-10-1

REF:

A) DWG DD 692-S4700-44

B) NAVSHIPS BK 347-0672

DWAC NO.

KEYOP	SH/WC	STD	MHRS	KEYOP TITLE	HRC	START	COMPL	AC	CRIT	KEVENT	I/R	REF
(2) 420	31B			REPAIR		09-08-1	10-17-1			2050		

31B E 400 SHOP 31B COMPLETELY DISASSEMBLE
26A E 8 COMPONENT PARTS FROM #1 & #2
56E 16 EMER. FEED PUMPS. CLEAN AND INSPECT
ALL PARTS FOR CONDITION AND WEAR.
RETURN ALL PUMP CLEARANCES TO STANDARDS
IN ACC/W REF'S A) & B).
REPLACE ALL DEFECTIVE PARTS, GASKETS AND FASTNERS.
PURCHASE OR MFR NON STANDARD PARTS, AND
THOSE PARTS NOT READILY AVAILABLE THRU THE
SUPPLY SYSTEM. — — —.

KEYOP	SH/WC	STD	MHRS	KEYOP TITLE	HRC	START	COMPL	AC	CRIT	KEVENT	I/R	REF
(1) 520	38A			DISASSEMBLE		09-03-1	10-07-1			2050		

38A E 160 SHOP 38A DISASSEMBLE STEAM & LIQUID ENDS OF #1 & #2
56C E 8 EMER. FEED PUMPS. CLEAN AND INSPECT ALL PARTS
56A E 16 FOR CONDITION & WEAR. TAG AND FORWARD TO SHOP 31B.
41A E 8 — — —.

KEYOP	SH/WC	STD	MHRS	KEYOP TITLE	HRC	START	COMPL	AC	CRIT	KEVENT	I/R	REF
(3) 521	38A			REASSEMBLE		10-18-1	11-10-1			2050		

38A E 96 SHOP 38A REASSEMBLE #1 & #2 EMER. FEED PUMPS.
72A E 24 ALIGN STEAM & WATER ENDS. ADJUST AND SET
56A E 32 ALL CLEARANCES. INSTALL ALL COMPONENT
41A E 8 PARTS. MAKE UP CLOSING SECTIONS. PREPARE FOR NORMAL OPNS

SHOP	11	17	26	31	38	41	56	36	51	67	64	71	72	99		
MHRS																
TOTAL MHRS																

SHIP SUPT	SHIP REPRESENTATIVE	COMPLETION DATE

BOSTON NAVAL SHIPYARD

377/DMC
25 OCTOBER 1972

USS NEPTUNE (ARC-2)

SCHEDULE OF MILESTONES

MILESTONE MANAGER	CONTROL NO.		
331.1	0010	START AVAILABILITY	11-01-2
331.1	0030	OFF LOAD OIL	11-03-2
911	3000	ACCESS COMPLETE	11-03-2
972	5805	CABLE DRUMS REMOVAL COMPLETE	11-06-2
972	3010	SSTG AND SWITCHBOARD REMOVALS COMPLETE	11-08-2
130	2030	BOILER INSPECTION REPORTS COMPLETE	11-14-2
938	5810	BOW SHEAVE REMOVAL COMPLETE	11-15-2
911	3020	SSTG GENERATOR AND SWITCHBD FDNS COMPLETE	11-17-2
972	0080	SLUDGE BARGE COMPLETE	11-17-2
938	5815	CABLE DRUM FOUNDATION SHIMMING COMPLETE	11-20-2
225	5000	PLANNING CUT OFF (NEW WORK)	11-22-2
938	3030	SSTG GENERATORS AND SWITCHBDS LANDED ON BOARD	11-27-2
931	5820	CABLE DRUMS & BEARING SHOP REPAIRS COMPLETE	11-28-2
964	9000	DOCK	11-29-2
938	5825	HYDRAULIC POWER UNIT REPAIRS COMPLETE	12-01-2
378	9050	INDOCK INSPECTION REPORTS COMPLETE	12-07-2
972	5830	INSTALL CABLE DRUMS	12-08-2
938	5835	DRAW OFF/HOLD BACK MACH OVHL COMPLETE	12-08-2
938	5845	INSTALL CABLE DRUM SPEED REDUCER	12-15-2
938	5840	CABLE DRUMS COMPLETE TOPSIDE	12-15-2
931	5850	BOW SHEAVES SHOP REPAIRS COMPLETE	01-02-3
938	5855	DRAW OFF/HOLD BACK INSTALLATION COMPLETE	01-05-3
938	3040	SSTG GENERATOR INSTALLATION COMPLETE	01-08-3
972	9100	UNDOCK	01-11-3
938	5860	CABLE HAULERS SHOP REPAIRS COMPLETE	01-12-3
951	3050	SWITCHBOARD INSTALLATION COMPLETE	01-12-3
911	5700	BUOY SKIDS MODIFICATION COMPLETE	01-12-3

377/DMC
25 OCTOBER 1972

USS NEPTUNE (ARC-2)

MILESTONE MANAGER	CONTROL NO.		
938	3060	SSTG GENERATOR FLUSHING COMPLETE	01-15-3
941	2050	LIGHT OFF	01-16-3
938	2055	START MACHINERY TEST	01-17-3
951	3070	START SSTG GENERATOR TESTS	01-18-3
938	5865	BOW SHEAVES COVERS AND A FRAME COMPLETE	01-26-3
938	5870	CABLE GEN ADJUST COMPLETE PWR AVAIL	01-26-3
956	5875	COMPLETE ELECTRICAL, PNEUMATIC, AND HYDRAULIC CHECK OUT OF CABLE MACHINERY SYSTEM	01-26-3
938	5880	CABLE HAULERS REINSTALLED COMPLETE	01-26-3
951	6650	TEST ROOM COMPLETE	01-26-3
972	5710	BUOY SKID TEST COMPLETE	01-26-3
938	5885	START CABLE MACHINERY TESTING	01-29-3
951	3080	SSTG GENERATOR TESTS COMPLETE	01-31-3
938	9200	DOCK TRIAL	02-01-3
938	9300	MACHINERY SEA TRIAL	02-08-3
972	5890	START CABLE MACHINERY ROUND ROBIN	02-12-3
331.1	9775	WATERFRONT COMPLETION	02-23-3
972	5895	COMPLETE ROUND ROBIN TEST	02-28-3
330	9800	AVAILABILITY COMPLETE	03-01-3

PREPARED BY: M. SHULMAN (EXT. 2181)

J R Donovan
HEAD, SCHEDULE SECTION

221

BOSTON NAVAL SHIPYARD

17 October 1972

MEMORANDUM:

From: Code 330
To: Code 300

Subj: Weekly Summary of Production Status

1. This summary contains comments on progress of controlling jobs and major problem areas.

2. Ship status reports are grouped in accordance with Type Desk assignment.

3. Explanation of headings and data:

MANNING:	Expended_____	Manday expended; from current MIS report PC-206A.
	Min required_____	Cumulative intended expenditure from current MIS report PF-210A.
	Est. total_____	Production's bi-weekly WLF estimate of final expenditure plus new work adjustment subsequent to 45% of the availability.
PLANNING:	Allowed_____	Manday issued from current MIS report PC-206A.
	Min. required_____	Planning allowance required to permit orderly manning and adequate physical progress.
	Est. total_____	Final manday allowance as estimated by Planning Department.
STATUS OF WORK:	Min. required_____	Lowest percentage of over-all work completion which will permit an orderly ship completion on schedule. Ratio of minimum required manning.
	Est. total_____	Percentage of overall work completion as estimated by Progress Branch.
REPORTS OVERDUE:	Number of overdue reports by specified shops to Planning Department as listed on current MIS report LD-205A.	

Very respectfully.

IND-BSK S- 700/2 (REV. 9-67) 1770

SHIP	LOCATION	SHIP SUPT
McDONNELL DE-1043 CDR SIMON	PP #4	LT ELLIOTT

AVAILABILITY	START	DRYDOCK IN	DRYDOCK OUT	TRIALS DOCK	TRIALS SEA	YD. COMPLETE
0	7/6	-	3/3/73	3/27/3	3/8/3	3/23/3

COMMENTS AS OF: 17 OCTOBER 1972	STATISTICS AS OF: 13 OCTOBER 1972

WORK DAYS				REPORTS OVERDUE
USED 70 / TOTAL 177	=	39	%	19-1, 22-1, 24-4, 31-1, 34-3, 35-8, 33-2, 38-3, 56-2, 87-2 TOTAL 26

STATUS OF WORK		JOB ORDERS TOTAL RECD	FUND PTS	SIGNED OFF
MINIMUM REQUIRED	%	133	NO FINAL	0
ESTIMATED	40 %			

FUNDING EXPENDED	MIN REQUIRED	EST. TOTAL	PLANNING ALLOWED	MIN REQUIRED	EST. TOTAL
14,895	13,165	35,390	31,812	-	32,200

1 NEXT SCHEDULED MILESTONES:

CODE	KEY	TITLE	COMMENTS
331.1	6000	Sewage metering facilities, 10/10	Date missed. Awaiting completion of repairs to APL-19. Estimate completion of MS on 10/20 or 10/24.
911	1271	Structural mods (rubber window complete, 10/16	Date missed. Awaiting manufacture of air lock doors. Expect completion of all other items by 10/18. No IR submitted.
911	1140	Structural mods helo hangar complete (LAMPS), 10/19	Expect to meet date.
911	1277	Bench and bulkhead test complete, 10/25	Expect to meet date.
911	1272	Window band section installed, complete, 10/31	Date is very tight because of amount of work involved.

2. CONTROLLING JOBS:

JOB NO.	DESCRIPTION	COMMENT ON PROGRESS
123-02 631-01	Fuel oil tank preservation Fresh water tank preservation	Blasting and painting of fresh water tanks progressing slowly. Accesses being cut in fuel oil tanks.
141-01 -02	Hangar mods LAMPS	Jobs progressing satisfactorily.

(3)

McDONNELL (DE-1043) Continued 17 October 1972

Controlling Jobs continued

Job No.	Description	Comment on Progress
165-01 -02	Rubber window installation	Ready to make final cut to banjo. Baedager enroute to ship for installation. There is a discrepancy between base line template and ship configuration.
221 series	Boiler and piping repairs	Removal of interference for replacement of outer row tubes 1A and 1B progressing slowly. Repairs to new superheater complete.
461-01	Active-passive sonar	Assembly of cooling system delayed due to non receipt of valves ordered on J/O 2234 205-01 (HS-31 34). Other work progressing satisfactorily.
640-650 series	Habitability package	Work behind due to repairs to AFL-19.

3. PLANNING DEPARTMENT - ACTION REQUIRED: (CUT-OFF DATE, 8/4)
   a. Attention is directed to report of LAMPS/sonar dome meeting of 10/10. (Code 212 action being taken).

   b. Resolution needed to discrepancy between baseline template and ship's sonar dome area configuration. (Code 212" L/O investigating).

4. PRODUCTION DEPARTMENT:
   a. Attention is directed to report of LAMPS/sonar dome meeting of 10/10.
   b. Close coordination is required among all shops within the next two weeks on all work in progress of:
      (1) Removal of interference around boilers
      (2) Installation of sonar dome head seat.

5. MATERIAL ITEMS:
   Number of priority "A" items 38

6. SUMMARY EVALUATION (CRITICAL COMPLETION, 2/2/73)

   Extension to 3/30/73 has been requested.

(3-1)

APPENDIX B.

REPORT NR: PC-105B

REPORT TITLE: ON-REQUEST STATUS REPORT, KEY OPERATION BY SHOP

FREQUENCY: ON REQUEST, DAILY

PURPOSE: To provide Production management with allowance and expenditure data relating to a specific users' request. The report may be used for research, analysis of shipyard performance, and the preparation of departure reports.

SEQUENCE: Ship/Project, Job Order Number, Key Operation Number

PAGE EJECT: Ship

NARRATIVE: This report is requested through Transaction Code 170, 171, 172, or 173. The codes are used to specify the levels of information to be considered as follows:

Transaction Code		Level of Data
170	-	Ship Availability
171	-	Work Category
172	-	Customer Order
173	-	Job Order

The user generally makes this request to Data Processing in memo form. In addition to specifying the name of the requestor (limit 20 digits), organization code (3 digits), serial number (4 digits), and desired report start and stop dates, one option is selected from each of the following four data categories:

Data Category 1:

"A" for KEYOP Work Center Level ☐

"B" for Job Order Shop Level ☐

"C" for KEYOP Shop Level ☐

Data Category 2:

Ship Availability ☐☐☐

Customer Order ☐☐☐☐☐

REPORT NR: PC-105B (Cont'd)

NARRATIVE: (Cont'd)

Data Category 2 (Cont'd):

Job Order ☐☐☐☐☐☐☐☐☐☐

Work Category 60-89 ☐☐

--If the ship availability level is specified, the report will contain the status of all job orders on that ship. If the customer order level is specified, the report will contain the status of all job orders within the customer order. If the status of only one job order is desired, the job order level is specified. Only one work category is specified at a time.

Data Category 3:

All Shops Note "All" ☐☐☐

A Group ☐☐☐

A Shop ☐☐

Data Category 4:

Open ☐

Closed ☐

Open and Closed ☐

Critical ☐

Held Up ☐

Canceled ☐

Transfers ☐

Limit % ☐

REPORT NR: PC-105B (Cont'd)

NARRATIVE: (Cont'd)

Data Category 4 (Cont'd):

--If open is checked, all job orders specified in Category 2 which are open will be reported. If the KEYOP/work center level was specified in Category 1, both open and closed key operations will be reported in PC-105B but only open KEYOPS will be reported in 104A and 105A.

--If closed is checked, all closed job orders as specified in Category 2 will be reported.

--If open and closed, critical, held up, canceled, or transfers is checked, only job orders or KEYOPS within the scope specified in Category 1 with the corresponding status will be reported.

--When using limit %, specify the percent of overexpenditure which must be reached before job orders or KEYOPS will be reported.

Additional options are now (summer 1971) being developed which will allow the user, through TC175, to specify particular groups of KEYOPS under the phase-oriented KEYOP numbering system.

This report assists in the comparison of KEYOPS by showing manhours allowed, manhours expended, and percent expended coupled with an indicator of the various levels of status.

Significant inputs affecting the report are:

Document	Significant Inputs	Code Typically Responsible for Input
Transaction Code 170, 171, 172, or 173	--Report request and options	Production Department management
TC574	--KEYOP start and completion dates	Work Status and Scheduling
	--KEYOP closure	First-line supervision
TC055 (time card)	--Manhours expended	First-line supervision
	--KEYOP completion	First-line supervision

ON-REQUEST STATUS REPORT, KEY OPERATION BY SHOP

PC-105B

ISSUE DATE 16 JUL 69
DATA DATE 15 JUL 69

(1) SHIP/PROJ: ROOSEVELT
(2) HULL-NO: CVA 42

(3) JO NUMBER/ (4) JO TITLE	(5) KO NUMBER/ (6) KO TITLE	(7) SCHED START/ (8) SCHED COMPL	(9) ACTUAL COMPL/ (10) CLOSED	(11) S I	(12) C R	(13) SHOP	(14) MH ALL	(15) MH EXP	(16) PCT EXP
1624210616	100	07-05-69	07-10-69						
DK BHD REPAIRS	FAB	07-10-69	07-15-69			11	32	32	100
						64	8	8	100
						72	40	40	100
			KEY-OP	4			80	80	100
	120	07-12-69	07-15-69						
	INSTALL	07-19-69			*	11	168	166	99
						17	56	54	96
						26	72	50	69
						41	8	8	100
						51	40	40	100
						56	58	54	113
						64	64	64	100
						72	72	28	39
			KEY-OP	1			528	464	88
			JOB ORDER				608	544	84
1624210618		07-11-69							
		12-14-69				56	500	100	20
						71	56		
			KEY-OP	0			556	100	20
			JOB ORDER	A			556	100	20
			CUST ORDER	A			1164	644	55

REPORT TYPE: STD MIS
ACTION: MODIFIED
DATE: 27 MAY 1970
CERTIFIED BY:

DISTRIBUTION 376 173 PC103C T SCHONBACH 16242 ALL OAC LAB 07159 07159

Volume 11
ON-REQUEST STATUS REPORT, KEY OPERATION BY SHOP

ITEM NR.	COLUMN HEADING	DE NR.	IDENTIFICATION OF DATA
1	SHIP/PROJ	0378	Ship/Project: The name of a ship, the hull type, and hull number or, if no name is assigned, only the hull designation. In the case of non-shipwork projects, the name of the project.
2	HULL-NO	0338	Hull Number: A combination of letters and digits assigned by NAVSHIPS to identify a ship by type of hull and serial number.
3	JO NUMBER	0161	Job Order Number: A 10-digit number assigned to a particular work item to identify labor and material charges.
4	JO TITLE	0231	Job Order Title: A brief descriptive title of the work to be performed under the job order.
5	KO NUMBER	0267	Key Operation Number: A three-digit number assigned to a key operation to identify the logical division of a job order.
6	KO TITLE	0380	Key Operation Title: The title, provided by the planner, for the key operation.
7	SCHED START	0377	Date, Scheduled to Start: The Gregorian date upon which the key operation is scheduled to start.
8	SCHED COMPL	0376	Date, Scheduled to Complete: The Gregorian date upon which the key operation is scheduled to complete.
9	ACTUAL COMPL	1825	Date, Key Operation Completed: The date a KEYOP completion notice is received and processed into the KEYOP record, or the scheduled completion date if the KEYOP is coded to be automatically closed.
10	CLOSED	1835	Date, Key Operation Closed: The date a KEYOP is closed to labor charges.
11	S I	1837/ 0644/ 1823	Status Indicator Code: The actual symbol that will appear in this column will be a Customer Charge Code (1837), a Job Order Charge Code (0644), or a Work Status Code (1823). The codes used are as follows:

ITEM NR.	COLUMN HEADING	DE NR.	IDENTIFICATION OF DATA
11 (Cont'd)			see below
12	C R	0629	Critical Code: An asterisk designates those jobs or key operations which are considered controlling or critical.
13	SHOP	0625	A two-digit number designating various production and non-production organizations of the shipyard.
14	MH ALL	0373	Manhour Allowance: The manhour values assigned to a work center on a key operation or any total of such values at a higher level. Hours are given in terms of should-cost.
15	MH EXP	0241	Manhours Expended: The number of manhours charged by the shop activity to the job level indicated.
16	PCT EXP	1289	Percent Expended: The percent of a key operation expended, computed by dividing manhours expended by manhours allowed. XXX% entered on a request indicates that the requested report is to include data only on those key operations for which the percent expended exceeds XXX%.

Item 11 (Cont'd):

Customer Charge Code	Job Order Charge Code	Work Status Code KO
A-Open to all charges	A-Open to all charges	0 Open
L-Open to labor charges only	L-Open to labor charges only	1 Completed by shop
M-Open to material charges only	M-Open to material charges only	2 Completed by date (auto)
P-Pre-priced/closed to all charges	C-Closed to all charges	3 Canceled
C-Closed to all charges	K-Canceled/closed to all charges	4 Closed other
D-Fiscal year to date expenditures summarized to CO level	H-Closed - Hold up	5 Closed by cancel
S-Closed - Screening	S-Closed - Screening*	6 Closed by date (auto)
Z-Closed - Dump status	Z-Closed - Dump status*	7 Closed by shop
		8 Record generated by program

*Used for work categories 59 and 60 only.

REPORT NR: PC-202B

REPORT TITLE: JEOPARDY REPORT, SHIP BY SHOP

FREQUENCY: WEEKLY

PURPOSE: This report indicates potential problem areas and provides Production management with the basis for investigative and corrective action on specific key operations which appear to be in jeopardy.

SEQUENCE: Ship, Shop, Key Shop Work Center, Job Order Number, Key Operation Number

PAGE EJECT: Ship

NARRATIVE: A KEYOP is defined as being in jeopardy if any one of the following four jeopardy conditions occur: Not started, not completed, above scheduled expenditures, below scheduled expenditures. These conditions are defined by the establishment of the following jeopardy control points: exception limit; Jeopardy Factor A, B, C, D: variance limit; and data date. Designators used to define these control points are briefly described below. The establishment of the control points should be made at shipyard policy level. Appendix D-2 contains a full discussion of the jeopardy area.

When a particular KEYOP is listed on the report for one of the above four reasons, additional data are provided for comparison purposes; for example, manhour allowances, manhour expenditures, and manhours scheduled are listed in neighboring report columns.

Significant inputs affecting the report are:

Document	Significant Inputs	Code Typically Responsible for Input
Transaction Code 574	--KEYOP start and completion dates	Work Status and Scheduling
	--KEYOP closure	First-line supervision
TC055 (time card)	--Manhours expended	First-line supervision
	--KEYOP completion	First-line supervision

REPORT NR: PC-202B (Cont'd)

NARRATIVE: (Cont'd) Designators and related jeopardy control points are as follows:

DESIGNATOR

PC20013 - Data Date
PC20020 - Jeopardy Factor A
PC20021 - Jeopardy Factor B
PC20022 - Jeopardy Factor C
PC20023 - Jeopardy Factor D
PC20024 - Exception Limit
PC20025 - Variance Limits

JEOPARDY REPORT, SHIP BY SHOP

PC-202B

ISSUE DATE 01 APR 70
DATA DATE 29 MAR 70

1 SHIP/PROJ KRAUS — 2 HULL/NO

3 SHOP	4 JO	5 JO TITLE	6 KO	7 CR	8 KO TITLE	9 ST	10 SK SH	11 WC	13 MH ALL	14 MH EXP	15 CI	16 MH SCH	17 PCT KO ELAPSD	18 SCHEDULED START	19 SCHEDULED COMPL	20 CONTROL INDICATOR
67	1405740405	AN/ULQ 6B ECM INST	014		RIPOUT		K67	A	488	560		488	100	021668	030168	NOT COMPLETED
						E	36	B	40	40						
						E	51	A	120	200						
						E	56	B	40	40						
						E	67	A	288	280						
67	1405740405	AN/ULQ 6B ECM INST	052		LOCAL CABL		K67	A	760	69		304	40	031868	041968	BELOW SCHED EXP
						E	11	D	32	0						
						E	26	B	64	0						
						E	67	A	648	69						
						E	72	D	16	0						
67	1405740406	INSTL AN/WLR 3	002		CABLING		K67	A	252	74		166	66	021968	041968	BELOW SCHED EXP
						E	11	D	12	12						
						E	11	E	8	0						
						E	26	B	16	0						
						E	26	D	8	0						
						E	51	A	120	48						
						E	51	B	16	0						
						E	67	A	64	14						
						E	72	D	8	0						
67	1405740406	INSTL AN/WLR 3	004		INSTALL		K67	A	52	0		52	100	031868	032968	NOT STARTED
						E	36	B	8	0						
						E	67	A	40	0						
						E	72	A	4	0						
67	1405740913	INSTL SSB LF MF E	002		RIPOUT		K67	A	224	144		244	100	021668	030168	NOT COMPLETED
						E	36	A	32	32						
						E	51	A	80	0						
						E	67	A	88	88						
						E	72	A	24	24						

REPORT TYPE: STD MIS

ACTION: MODIFIED

DATE: 27 MAY 1970

CERTIFIED BY: H. J. Petrovic

CR=CRITICAL CODE IND. ST=TYPE STANDARD K=KEY SHOP CI=COMPLETION IND. PCT KO ELAPSD=PERCENT KEY OPERATION TIME ELAPSED

DISTRIBUTION SEE DISPATCHER   ALL=ALLOWANCE   EXP=EXPENDITURES   SCH=SCHEDULED

Volume 11
JEOPARDY REPORT, SHIP BY SHOP

ITEM NR.	COLUMN HEADING	DE NR.	IDENTIFICATION OF DATA
1	SHIP/PROJ	0378	Ship/Project: The name of a ship, the hull type, and hull number or, if no name is assigned, only the hull designation. In the case of non-shipwork projects, the name of the project.
2	HULL/NO	0338	Hull Number: A combination of letters and digits assigned by NAVSHIPS to identify a ship by type of hull and serial number.
3	SHOP	0625	A two-digit number designating various production and non-production organizations of the shipyard.
4	JO	0161	Job Order Number: A 10-digit number assigned to a particular work item to identify labor and material charges.
5	JO TITLE	0231	Job Order Title: A brief descriptive title of the work to be performed under the job order.
6	KO	0267	Key Operation Number: A three-digit number assigned to a key operation to identify the logical division of a job order.
7	C R	0629	Critical Code: An asterisk to designate those jobs or key operations which are considered controlling or critical.
8	KO TITLE	0380	Key Operation Title: A brief descriptive title of the work involved in the key operation.
9	S T	0473	Standard Type: An alphabetic code for type of standard as follows: Type U - Uniform Type E - Engineered Type A - Estimated Type 0 - Non-standard A blank indicates that no standard code, or an invalid standard code, was assigned.
10	K	1159	Key Shop Indicator: A code "K" to indicate a shop designated as being responsible for coordinating and progresssing a key operation.

PC-202B (Cont'd)

ITEM NR.	COLUMN HEADING	DE NR.	IDENTIFICATION OF DATA
11	SH	0625	Shop: A two-digit number designating various production and non-production organizations of the shipyard.
12	WC	0269	Work Center: The identifying number of a shop subdivision, generally based on the organizational structure of the shop, located in a centralized area under one designated supervisor.
13	MH ALL	0373	Manhour Allowance: The manhour values assigned to a work center on a key operation or any total of such values at a higher level. Hours are given in terms of should-cost.
14	MH EXP	0241	Manhours Expended: The number of manhours charged by the shop activity to the job level indicated.
15	C I	0628	Completion Indicator: An asterisk to indicate that a shop work center has reported work complete.
16	MH SCH	0375	Manhours Scheduled: The number of manhours which would have been expended on the specific key operation through the report data date. Derived by multiplying the percent of key operation time elapsed by key operation manhour allowance.
17	PCT KO ELAPSD	0372	Percent Key Operation Time Elapsed: Number of workdays since scheduled start date, divided by total number of workdays scheduled.
18	SCHEDULED START	0377	Scheduled to Start Date: The Gregorian date on which the key operation is scheduled to start.
19	SCHEDULED COMPL	0376	Scheduled to Complete Date: The Gregorian date on which the key operation is scheduled to complete.
20	CONTROL INDICATOR	0370	Control Indicator: A descriptive phrase used to indicate the condition which is causing a jeopardy item. The conditions are as follows: --Not Started: Scheduled start date past but zero expended. --Not Completed: Scheduled completion date past but not reported complete. --Above Scheduled Expenditures: Manhours expended greater than scheduled expenditures and outside of control and variance limits. --Below Scheduled Expenditures: Manhours expended less than scheduled expenditures and outside of control and variance limits.

REPORT NR: PC-202G

REPORT TITLE: KEY OPERATIONS SCHEDULED TO COMPLETE, BY SHOP

FREQUENCY: WEEKLY

PURPOSE: To enable Production Department management to monitor key operations that are scheduled to complete within a particular time frame, and to take corrective actions, when necessary, before completion dates are passed.

SEQUENCE: Shop, Key Shop Work Center, Ship, Scheduled Completion Date, Job Order Number, Key Operation Number

PAGE EJECT: Key Shop, Key Shop Work Center, Ship

NARRATIVE: For each KEYOP, the report provides data concerning manhours allowed, expended, and the resulting balance. This facilitates comparison of the work to be accomplished with the time remaining before the completion date, which indicates whether the KEYOP schedule will slip.

Significant inputs affecting the report are:

Document	Significant Inputs	Code Typically Responsible for Input
Transaction Code 574	--KEYOP start and completion dates	Work Status and Scheduling
	--KEYOP closure	First-line supervision
TC055 (time card)	--Manhours expended	First-line supervision
	--KEYOP completion	First-line supervision

As noted above, only KEYOPS scheduled to complete within a particular time frame appear on the report. This time frame is specified by using two factors input through the use of two designators as shown below:

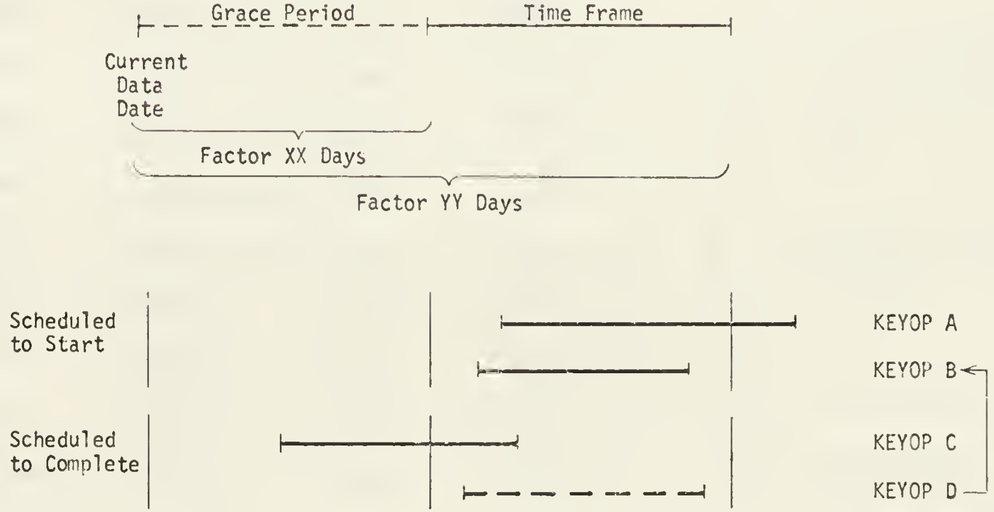
```
Factor XX - Designator PC20017          Factor YY - Designator PC20018

ØØØØØØ NN                               ØØØØØØ NN
 |     |__ Workdays                      |     |__ Workdays
 |________ Zero                          |________ Zero
```

The current data date is specified through use of Designator PC20013. As the following figure indicates, Factor XX defines a period of time following the current data date during which KEYOPS scheduled to complete will not appear on the report. This might be called a grace period, and allows for normal variations in actual completions. Factor YY in conjunction with XX defines the time frame. A modification is being made which will enable the user (by winter 1971) to specify a past or future time frame. The example shows KEYOPS

REPORT NR: PC-202G (Cont'd)

NARRATIVE: (Cont'd)

scheduled both to start and to complete because they are interrelated. Only those KEYOPS scheduled to complete during the time frame and scheduled to start before the time frame (KEYOP C) will appear on the scheduled to complete reports. KEYOPS scheduled to start within the time frame (KEYOPS A, B, and D) will appear on the scheduled to start reports.



KEY OPERATIONS SCHEDULED TO COMPLETE, BY SHOP

ISSUE DATE 06 JUN 69
DATA DATE 06 JUN 69

PC-202G

(1) SHOP 51

(2) WC	(3) SHIP/PROJ	(4) JO NUMBER/ (5) JO TITLE	(6) KO NUMBER/ (7) KO TITLE	(8) C R	(9) SCHED START/ (10) SCHED COMPL	(11) TIMES RESCH	(12) MH ALL/ (13) MH EXP	(14) MH BAL	(15) ASSIST SHOP WORK CENTERS	(16) A C (17) COMPL RESCH
A	FURER	1405930005 SET UP TRANSFORMERS	011 SET UP	*	06-05-69 06-09-69	2 0	64 118	-54	11C 51B 64A	
A	FURER	1405940102 TEST IC CIRCUITS	003 TEST		06-05-69 06-11-69	0 2	16	16	51B	
A	FURER	1405940116 MODIFY IC SWITCHBOXES	001 MODIFY	*	05-19-69 06-12-69	1 1	75 61	14	11B 11C 11D 26A 26B 41C 51B 64A 64B 71P	
A	FURER	1405940225 INST GUN FIRE CTL SYS	004 INSTALL		06-02-69 06-12-69	0 0	214 8	206	11B 11C 11D 26B 26C 51B 71P	
A	FURER	1405910001 REMOVE INTERFERENCES	004 INTERF		04-28-69 06-13-69	0 0	32 24	8	51B	
A	FURER	1405930305 INSTALL LIGHTING SYS	001 INSTALL		04-28-69 06-13-69	0 1	118 102	16	11B 11D 26B 26C 51B 64A 64B 71P	
A	THOR	1655520028 REPAIR ELEV	007 INSTALL		05-27-69 06-09-69	0 0	120 72	48	51B 64B	
A	THOR	1655550104 VENT REPAIRS	004 MODIFY		06-02-69 06-13-69	0 0	48 12	36	51B	
A	THOR	3055552011 REGULATOR RENEW	002 RIPOUT		05-14-69 06-18-69	0 0	212 32	180	11D 17B 26D 51B 72A	
A	YORKTOWN	4057150104 FAN RM 01-25	002 INSTALL		06-09-69 06-12-69	0 0	48 12	36	26B 26C 72A	
A	YORKTOWN	4057150104 FAN RM 01-25	003 INSTALL		05-19-69 06-13069	0 0	112 88	24	26B 26C 64A 71P	

REPORT TYPE: STD MIS

ACTION: MODIFIED

DATE: 27 MAY 1970

CERTIFIED BY: F. J. Petrovic

DISTRIBUTION (SEE DISPATCHER)

Volume 11
KEY OPERATIONS SCHEDULED TO COMPLETE, BY SHOP

ITEM NR.	COLUMN HEADING	DE NR.	IDENTIFICATION OF DATA
1	SHOP	0625	A two-digit number designating various production and non-production organizations of the shipyard.
2	WC	1824	Key Shop Work Center: A shop work center with additional responsibilities with respect to key operation status.
3	SHIP/PROJ	0378	Ship/Project: The name of a ship, the hull type, and hull number or, if no name is assigned, only the hull designation. In the case of non-shipwork projects, the name of the project.
4	JO NUMBER	0161	Job Order Number: A 10-digit number assigned to a particular work item to identify labor and material charges.
5	JO TITLE	0231	Job Order Title: A brief descriptive title of the work to be performed under the job order.
6	KO NUMBER	0267	Key Operation Number: A three-digit number assigned to a key operation to identify the logical division of a job order.
7	KO TITLE	0380	Key Operation Title: A brief descriptive title of the work involved in the key operation.
8	C R	0629	Critical Code: An asterisk to designate those jobs on key operations which are considered controlling or critical.
9	SCHED START	0377	Scheduled to Start Date: The Gregorian date on which the key operation is scheduled to start.
10	SCHED COMPL	0376	Scheduled to Complete Date: The Gregorian date on which the key operation is scheduled to complete.
11	TIMES RESCH	1874/ 1875	Times Rescheduled: The number of times a key operation scheduled start date has been revised (1874) or the number of times a key operation scheduled completion date has been revised (1875).
12	MH ALL	0373	Manhour Allowance: The manhour values assigned to a work center on a key operation or any total of such values at a higher level. Hours are given in terms of should-cost.

KEY OPERATIONS SCHEDULED TO COMPLETE, BY SHOP

PC-202G (Cont'd)

ITEM NR.	COLUMN HEADING	DE NR.	IDENTIFICATION OF DATA
13	MH EXP	0241	Manhours Expended: The number of manhours charged by the shop activity to the job level indicated.
14	MH BAL	0895	Manhours Balance: Manhours expended subtracted from manhour allowance.
15	ASSIST SHOP WORK CENTERS	0645	Any shop work center, other than the key shop work center, which is involved in the performance of the work of a specific key operation.
16	A C	1298	Automatic Closure Code: A code "A" to indicate that a key operation will automatically close at the scheduled completion date plus "N" days.
17	COMPL RESCH	--	Completed or Rescheduled: Space provided for shop personnel to indicate that a job has been completed, should be rescheduled, or that a problem exists which requires higher action.

REPORT NR: PF-215A

REPORT TITLE: WORKLOAD FORECAST, SHIP BY SHOP
WORKLOAD FORECAST, SHIP BY CODE

FREQUENCY: WEEKLY

PURPOSE: To assist Production Department or Design Division management to compare cumulative forecast with expenditures to date, and compare these figures with a one-year forecast.

SEQUENCE: Option 1. Ship, Shop
2. Ship, Code

PAGE EJECT: Ship

NARRATIVE: The report contains a total forecast, a cumulative forecast to date, and a one-year forecast for each ship by shop (or code), and for non-shipwork and overhead work by shop (or code). Expenditures (mandays for shops, manhours for codes) are presented in conjunction with cumulative forecast figures. Availability start and completion dates are also given.

Ship management officers, ship superintendents, shop planners, shop heads, and design managers may review the reports to compare cumulative forecast with expended figures. For example, if the availability is well under way and cumulative expenditures are far below the forecast, corrective action should be taken with the appropriate organizations.

Report accuracy depends on several significant inputs as noted below:

Document	Significant Inputs	Code Typically Responsible for Input
Transaction Code 260 (new data), 261 (revised data)	--Availability start and completion dates --Workload estimate --Manning curve number	Work Status and Scheduling (Production) Workload Coord. and Control (Design)
TC273	--Manning curve shape	Same as above
TC275, 276	--Workload estimate allocation	Same as above
TC262 (new data), 263 (revised data)	--External loading	Same as above
TC264 (new data), 265 (revised data)	--Fixed loading	Same as above
TC160	--Revision of shop performance factors	Methods and Standards
TC055 (time card)	--Manhours expended	Shop/Design personnel

PF-215A

WORKLOAD FORECAST, SHIP BY SHOP

ISSUE DATE 26 JUN 70
DATA DATE 26 JUN 70

(1) SHIP/PROJ (2) HULL NO.	(3) START (4) COMP	(5) SHOP	(6) TOTAL FORECAST	(7) NOT SPRD	(8) CUM FCST (9) EXPENDED	JUN 29	JUL 06	13	(10) 20	27	AUG 03	10	17	24	31	SEP 07	14
DAVIS X DD 937	11039 12040	06	80		50		1	1	1	1	1	1					
		11	16250		11830	55	55	55	53	50	50	50	50	50	50	50	50
		17	13000		7265	75	67	60	60	60	60	60	60	60	60	60	60
		23	160		120	1	1	1	1	1	1	1	1				
		26	13000		10225	50	50	40	39	35	35	35	35	35	30	30	30
		31	8410		7095	30	30	20	20	20	15	10	10	10	10	10	10
		35	855		710	3	3	3	3	3	3	3	2	2	1	1	1
		36	10310		5855	50	50	50	50	50	50	50	50	50	50	50	50
		37	315		200	2	2	2	2	2	2	1	1	1	1	1	1
		38	10700		6265	50	50	50	50	50	50	50	50	50	50	50	50
		41	5800		3935	50	50	50	45	35	30	10	10	10	10		10
		51	20030		11395	115	115	113	110	110	100	100	[illegible]				9
		56	19150		10665	115	120	120	120	121							
		64	6050		3490	30	30	30	30								
		67	8000		5235	45	40	40	35								
		71	5600		2485	25	25	25	25								
		72	12000		8245	35	35	35	35							[illegible]	47
		81	5				1										
		94	245		225	1	1	1	1								
		99	2705		1670	8	9	9	9	9	9	9	14	16	14	12	12
		ALL	152665		96960	740	735	705	689	673	666	636	643	609	596	594	596

REPORT TYPE: STD MIS
ACTION: RETAIN
DATE: 27 MAY 1970
CERTIFIED BY: H. J. Petrovic

DISTRIBUTION (SEE DISPATCHER)

LEFT PAGE

PF-215A (Cont'd)

WORKLOAD FORECAST, SHIP BY SHOP

ISSUE DATE 26 JUN 79
DATA DATE 26 JUN 79

SHIP/PROJ HULL NO.	START COMP	SHOP	TOTAL FORECAST	NOT SPRD	CUM FCST EXPENDED	JUN 29	JUL 06	13	20	27	AUG 03	10	17	24	31	SEP 07	14

NOTES:

A "right page" follows this "left page." The right page contains data for 14 additional weeks plus six monthly summaries.

Additional information will appear in above format for:

--OTHER SHIPS
--UNKN RA TA (Unknown Restricted Availabilities and Technical Availabilities)
--OTHER PROD (Manufacturing and Other Productive Work)
--MIL SUPP (Military Support)
--EXPENSE
--SCHOOLING
--ABSENCES

When this report is produced for design workload forecast, "Code" will be used in lieu of "Shop" in report title and column heading. In addition, Design Division reports in "Manhours" in lieu of "Mandays".

DISTRIBUTION (SEE DISPATCHER)

LEFT PAGE

Volume 12
WORKLOAD FORECAST, SHIP BY SHOP
WORKLOAD FORECAST, SHIP BY CODE

ITEM NR.	COLUMN HEADING	DE NR.	IDENTIFICATION OF DATA
1	SHIP/PROJECT	0378	Ship/Project: The name of a ship and the hull type and number or, if no name is assigned, then only the hull designation. In the case of non-shipwork projects, the code name of the project.
2	HULL NO	0338	Hull Number: A combination of letters and digits assigned by NAVSHIPS to identify a ship by type of hull and serial number or a locally assigned identification number for a project.
3	START	0620	Start Date: The Gregorian date upon which an item of work on a ship availability is scheduled to commence. Positions 1 and 2 are month, 3 and 4 are day of month, 5 is year (1971=1).
4	COMP	0621	Completion Date: The Gregorian date upon which an item of work on a ship availability is scheduled to complete. Positions 1 and 2 are month, 3 and 4 are day of month, 5 is year (1971=1).
5	SHOP	0625	A two-digit number designating various production and non-production organizations of the shipyard.
6	TOTAL FORECAST	--	Mandays forecast for shipwork, manufacturing and other productive work (OTHER PROD), and military support (MIL SUPP).
7	NOT SPRD	1953	Not Spread: Mandays not spread over time periods covered by the report because of rounding.
8	CUM FCST	1777	Cumulative Forecast: The number of mandays which, according to the forecast, should have been expended up to and including the data date.
9	EXPENDED	0546	Mandays Expended: The manhours expended divided by eight.
10	Remainder of Columns	--	Forecast: The average men per day forecast for period indicated. This forecast is derived from spreading the workload estimate over the appropriate time span in accordance with curves provided and specified by the Production Department. From the standpoint of a manning curve, it is the area under the curve divided into time periods. The date columns (JUN29, JUL06, etc.) start with the manday following the data date, and thereafter are one-week periods starting with manday. Twenty-six weekly periods are listed on the report followed by six monthly periods; the first "month" consists of the remaining portion of a month when the 26th week does not end on the last day of the month.

REPORT NR: PM-202C

REPORT TITLE: SHOP PERFORMANCE, SCHEDULE, SUMMARY — FREQUENCY: WEEKLY

PURPOSE: To provide Production Department management with schedule adherence data in order to evaluate and improve shop or shop group schedule performance.

SEQUENCE: Shop — PAGE EJECT: NONE

NARRATIVE: This report provides information concerning KEYOPS scheduled to complete and KEYOPS completed in terms of the number of KEYOPS, and the mandays related to these KEYOPS. This information is totaled by shop and combined to give a percent scheduled adherence which is the ratio between KEYOPS and mandays completed and those scheduled to complete. For example, a review of the report may indicate that Shop 72 is completing 9 percent of the number of KEYOPS on schedule, and 26 percent of the related manhours on schedule. A significantly low percentage for a particular work center may lead to a review of the PC-202G report (Key Operations Scheduled to Complete, By Shop), and PC-202A report (Jeopardy Report, Shop By Ship), where an analysis can be made of individual KEYOPS related to the particular shop.

DESIGNATORS: The following designators closely relate to the PM-202C report:

PC20260 ("N" Day Period). The "N" day concept permits Production Department personnel to report work complete but allows them to submit charges if unexpected additional work arises. When a completion is reported, it activates a counter which automatically closes the work to charges after a period of "N" days.

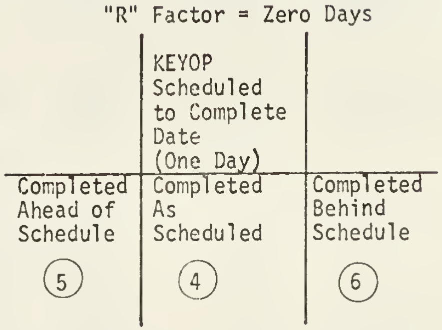
Designator format is as follows:

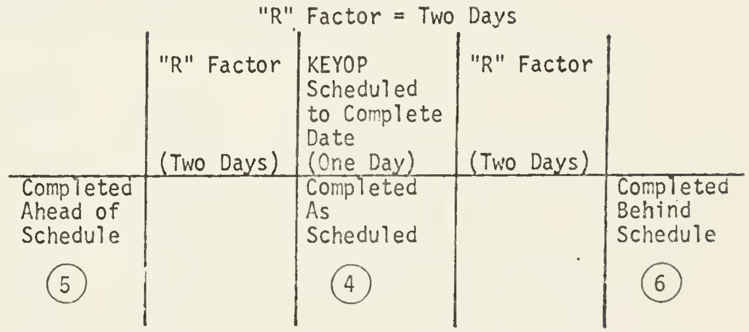
```
NN bbbbbb
|   |
|   |_____ Blank
|_________ Number of "N" Days
```

PC20019 ("R" Factor). A particular number of days added to or subtracted from KEYOP completion dates for purposes of this report are called the "R" factor. "R" factor days, established through the use of PC20019, increase the period of time when a KEYOP is considered to be completed as scheduled (item 4 on report format). For example, if "R" were zero days, the only time a KEYOP would be considered completed as scheduled is if it were completed on the scheduled to complete date. The "R" factor days added to and subtracted from the KEYOP scheduled to complete date increase this time period. For example:

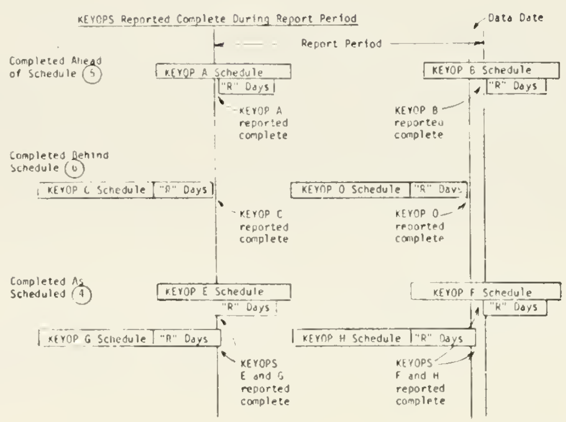
REPORT NR: PM-202C

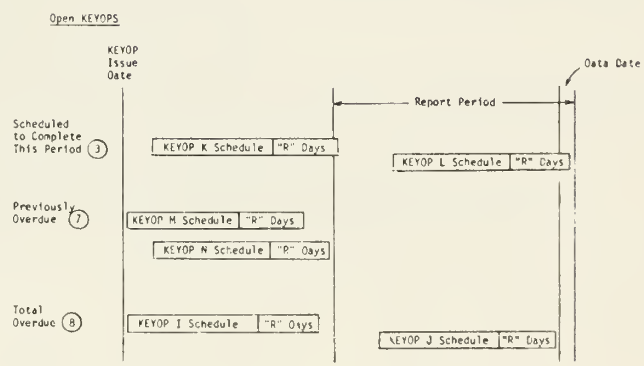
DESIGNATORS: (Cont'd)





The following charts relate specific schedule report headings to the corresponding family of KEYOPS. For example, all KEYOPS designated as "Completed Ahead of Schedule" (item 5 on report format) would fall between KEYOPS A and B as noted below. The first charts pertain to KEYOPS reported complete during the report period. The second group of charts pertains to open KEYOPS.





PM-202C

SHOP PERFORMANCE, SCHEDULE, SUMMARY
06 JUN 69 THRU 20 JUN 69

ISSUE DATE 20 JUN 69
DATA DATE 20 JUN 69

(1) SHOP		(2) SCHED TO COMPL THIS PD	(3) COMPL AS SCHEDULED	(4) COMPL AHEAD OF SCHEDULE	(5) COMPL BEHIND SCHEDULE	(6) PREVIOUS OVERDUE	(7) TOTAL OVERDUE	(8) PCT SCHED ADHERENCE
72	KO	328	23	31	112	1587	1780	9
	MD	1882	71	521	1096	4681	5396	26
81	KO	9	1		4	24	28	3
	MD	13	4		10	66	65	
94	KO	14	10		13	83	80	11
	MD	42	30		6	174	180	14
99	KO	123	14	50	33	369	445	15
	MD	483	45	284	55	670	1053	32
(9) TOTAL	KO	639	73	131	217	2767	2832	12
	MD	2585	175	855	1216	6295	7193	15

Volume 13
SHOP PERFORMANCE, SCHEDULE, SUMMARY

ITEM NR.	COLUMN HEADING	DE NR.	IDENTIFICATION OF DATA
1	SHOP	0625	A two-digit number designating various production and non-production organizations of the shipyard.
2	SCHED TO COMPL THIS PD	0431	Key Operations Scheduled to Complete (This Period): Number of open key operations whose scheduled completion date plus "R" days lies within the report period. "R" day is to be supplied by the using yard.
3	COMPL AS SCHEDULED	0424	Key Operations Completed as Scheduled: The quantity of key operations reported complete by the work center, on which the completion action was received by Data Processing within the time span established by the current schedule adherence factor.
4	COMPL AHEAD OF SCHEDULE	0422	Key Operations Completed Ahead of Schedule: The number of key operations reported complete by the key shop prior to "R" days ahead of scheduled completion dates.
5	COMPL BEHIND SCHEDULE	0425	Key Operations Completed Behind Schedule: Key operations completed during the report period which completed after the scheduled completion date plus "R" days.
6	PREVIOUS OVERDUE	0461	Key Operations Previous Overdue: The number of open key operations whose scheduled completion date plus "R" days lies prior to the report period.
7	TOTAL OVERDUE	0472	Key Operations Overdue: Total open key operations with a scheduled completion date earlier than the report date minus "R" working days. "R" is to be supplied by the using yard. (Column 6 - 5 plus Column 2 - 3.)
8	PCT SCHED ADHERENCE	0458	Percent, Scheduled Adherence of Key Operations: The number of key operations reported complete during the period of the report, divided by the number of key operations whose scheduled completion date plus "R" days lies within the period covered by the report plus the total number of key operations overdue on last report. Formula: $\dfrac{\text{Compl as Sched } 3 + \text{Compl Ahead of Sched } 4 + \text{Compl Behind Sched } 5}{\text{Sched to Compl This Pd } 2 + \text{Previous Overdue } 6}$ NOTE: MD figures are the total number of mandays allowed on the key operations in each category.

ITEM NR.	COLUMN HEADING	DE NR.	IDENTIFICATION OF DATA
9	TOTAL	--	Summation of key operations and mandays by column.

REPORT NR: PM-208A

REPORT TITLE: LEADINGMAN PERFORMANCE ON COMPLETED WORK FREQUENCY: WEEKLY, ON REQUEST

PURPOSE: To provide shop supervision with information on work completed or charged during a specific reporting period to be used as the basis for management action to help leadingmen maintain or increase the effectiveness of labor performance.

SEQUENCE: Shop, Leadingman Code PAGE EJECT: Shop

NARRATIVE: This report contains data such as percent performance (allowance divided by expenditure) by engineered and non-engineered standard, and by manhour allowance.

DESIGNATORS: Designator PM20103 is used to specify the method used for report data selection. Two options are available:

Option 1. The report will be based only on data related to work reported complete during the week covered by the report. The format is as follows:

bbbbbbbb
Blank

Option 2. The same as Option 1, plus data from work that has been completed or closed prior to the report period but against which current charges have been made. The format is as follows:

ONE-WEEK
Fill in with "One-Week"

LEADINGMAN PERFORMANCE ON COMPLETED WORK

PM-208A

ISSUE OATE 09 MAY 69
OATA OATES 05 MAY 69 THRU 09 MAY 69

1 SHOP NO	2 LOGM COOE	3 TOT PERF ALL/EXP	TOTAL MANHOUR 4 ALLOW	5 EXPEND	6 PERF ALL/EXP	ENGINEEREO 7 ALLOW	8 EXPEND	9 PERF NOT ENGINEERED ALL/EXP	10 ALLOW	11 EXPENO	DATA INOICES * A	B	C
17	**	.40	8	20				.40	8	20			
17	00		228			60			168				
17	05	.10	24	239	1.50	24	16			223	1.00	.11	.40
17	07	.36	32	B8				.36	32	88			.45
17	47	.43	81	187	1.00	4	4	.42	77	183	.41	.35	.50
17	69	1.17	604	518	1.55	136	88	1.09	468	430	.68	1.01	.44
17	70	.67	72	108				.67	72	108	.56	.71	.38
17	93			32						32			
12 17	TOTAL	.78	1269	1630	1.25	404	322	.66	865	1308	.72	.75	.42
***94	TOTAL	.73	288	396	.50	4	8	.73	284	388	1.00	.77	
97	NO DATA TO REPORT ON SHOP/WORK CENTER RECORDS COMPLETED DURING THE REPORT PERIOD												
99	TOTAL	1.06	3315	3114	1.11	2705	2442	.91	610	672	.12	.84	.39
13 PROD	TOT	.96	103254	107045	.92	44896	49043	1.01	58358	57963	.24	1.06	.39

DEFINITIONS ANO FORMULAS

Responsible Leadingman (LDGM) is determined by one of the following conditions:
(1) LOGM is only one charging to the work center record
(2) LDGM making largest total expenditures, when more than one LDGM makes charges to the W/C record
(3) LDGM making the last charge in the event that more than one leadingman qualifies under (2), above

LDGM 00: A fictitious entry used to record total manhour allowances against which no expenditures were reported on the completed work. These data are not used in the calculation of any performance indices

LDGM **: A fictitious entry used to record the total manhour allowances and the total manhour expenditures for all LDGM reporting under other than a numerically designated leadingman number. These data are used in the calculation of performance indices.

NOTE: With exception of LOGM 00, allowance data cannot be established without a corresponding expenditure transaction.

*INDEX A: $\frac{\text{Tot MHA for line items with Exp by responsible LDGM (1) only}}{\text{Tot MHA for line items with Exp by all leadingmen}}$ = Percent of MHA used exclusively by responsible LDGM (1)

*INDEX B: $\frac{\text{Tot MHA for line items with Exp by responsible LDGM (1) only}}{\text{Tot Exp for line items with Exp by responsible LDGM (1) only}}$ = Responsible leadingman performance

*INDEX C: $\frac{\text{Tot Exp for line items with Exp by other than responsible LDGM}}{\text{Tot Exp for line items with Exp by all leadingmen except Resp LDGM (1)}}$ = Percent of M/H Exp by other than Resp LOGM

***Page break will occur for actual reports

ITEM NR.	COLUMN HEADING	DE NR.	IDENTIFICATION OF DATA
1	SHOP NO	0625	A two-digit number designating various production and non-production organizations of the shipyard.
2	LDGM CODE	0369	A two-digit number assigned to a leadingman, by a shop, for identification purposes.
3	TOT PERF ALL/EXP	0459	Percent Performance (Total): Percent obtained by dividing the manhour allowance for closed work by the manhours expended for closed work.
4	TOTAL MANHOURS ALLOW	0373	Manhour, Allowance (Total): The manhour allowances assigned to a work center on a key operation or any total of such values at a higher level.
5	TOTAL MANHOURS EXPEND	0241	Manhour, Expended (Total): The number of manhours charged by the shop activity to the job level indicated.
6	PERF ALL/EXP	0459	Percent Performance (Engineered): Percent obtained by dividing the engineered manhour allowance for closed work by the manhours expended for closed work.
7	ENGINEERED ALLOW	0642	Allowance, Manhour (Engineered): The number of manhours allowed identified as engineered quality.
8	ENGINEERED EXPEND	0241	Manhour, Expended (Engineered): The number of manhours expended against engineered standard allowances.
9	PERF NOT ENGINEERED ALL/EXP	0459	Percent Performance (Not Engineered): Percent obtained by dividing the manhour allowance for closed work by the manhours expended for closed work.
10	PERF NOT ENGINEERED ALLOW	0373	Manhour, Allowance (Not Engineered): The number of manhours allowed identified as estimated or non-standard quality.
11	PERF NOT ENGINEERED EXPEND	0241	Manhour, Expended (Not Engineered): The number of manhours expended against allowances of other than engineered quality.

ITEM NR.	LINE HEADING	DE NR.	IDENTIFICATION OF DATA
12	TOTAL	--	The totals of all the columns for the shop indicated.
13	PROD TOT	0624	Totals, Production Shop: The totals of all rows or columns of data for Production Department shops. This total and the summary of each shop (starting here with shop 06) appear at the end of the report.

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